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(54) **END EFFECTOR ASSEMBLY FOR BIPOLAR PENCIL**

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(Continued)

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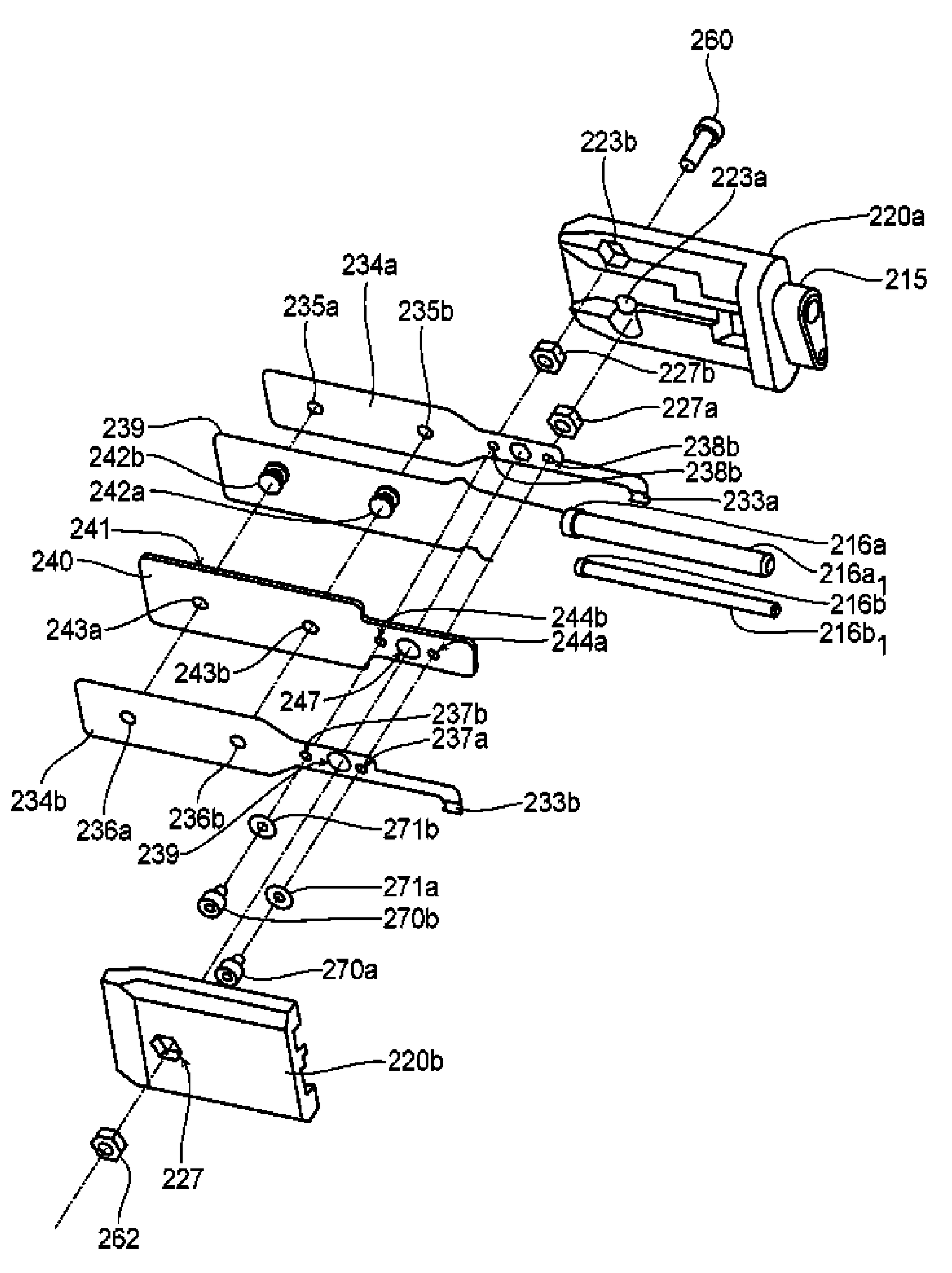
(57) **ABSTRACT**

An electrode assembly for an electrosurgical instrument includes a housing having an active electrical connector and a return electrical connector configured to operably engage a distal end of an electrosurgical instrument shaft, the housing encapsulating an elongated return electrode and a pair of insulative tubes configured to house a wire-like active electrode. The elongated return electrode includes a clevis at a distal end thereof and operably engages to the return electrical connector at a proximal end thereof. The wire-like active electrode operably engages at one end to the active electrical connector. A donut-like insulator is operably engaged to the clevis of the elongated return electrode and is configured to support the wire-like active electrode there-around. A tensioning mechanism is configured to operably engage an opposite end of the wire-like electrode and tension the wire-like active electrode about the donut-like insulator during assembly.

20 Claims, 12 Drawing Sheets



(51) **Int. Cl.**

A61B 18/16	(2006.01)
A61B 18/00	(2006.01)
A61B 17/00	(2006.01)

(52) **U.S. Cl.**

CPC *A61B 18/149* (2013.01); *A61B 2017/0088* (2013.01); *A61B 2017/00367* (2013.01); *A61B 2017/00734* (2013.01); *A61B 2018/00077* (2013.01); *A61B 2018/00178* (2013.01); *A61B 2018/00589* (2013.01); *A61B 2018/00595* (2013.01); *A61B 2018/00601* (2013.01); *A61B 2018/00684* (2013.01); *A61B 2018/00946* (2013.01); *A61B 2018/126* (2013.01); *A61B 2018/1253* (2013.01); *A61B 2018/144* (2013.01); *A61B 2018/1407* (2013.01); *A61B 2018/1412* (2013.01); *A61B 2018/1495* (2013.01)

(58) **Field of Classification Search**

CPC A61B 18/16; A61B 2017/00367; A61B 2018/00178; A61B 2018/00946

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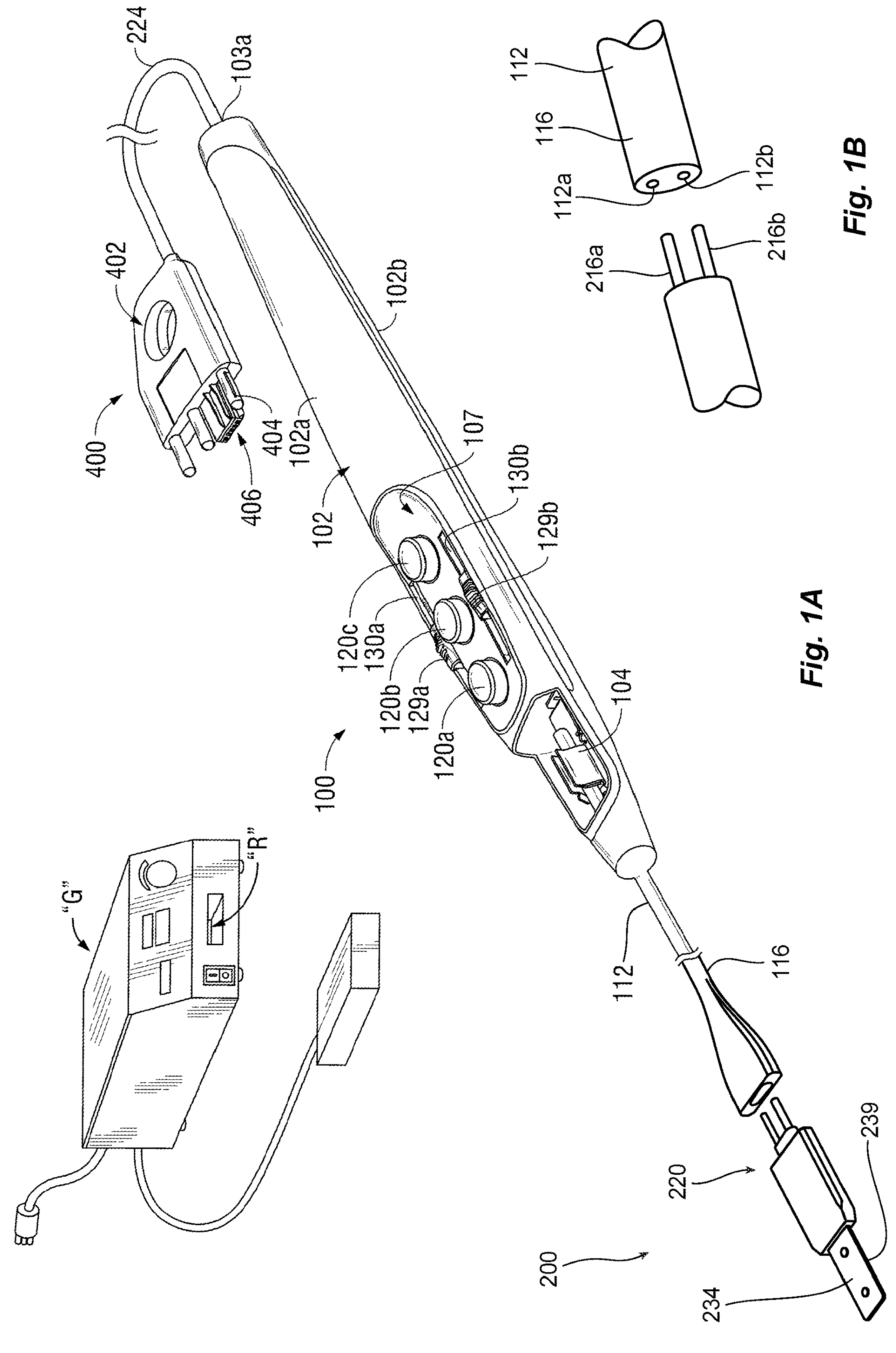
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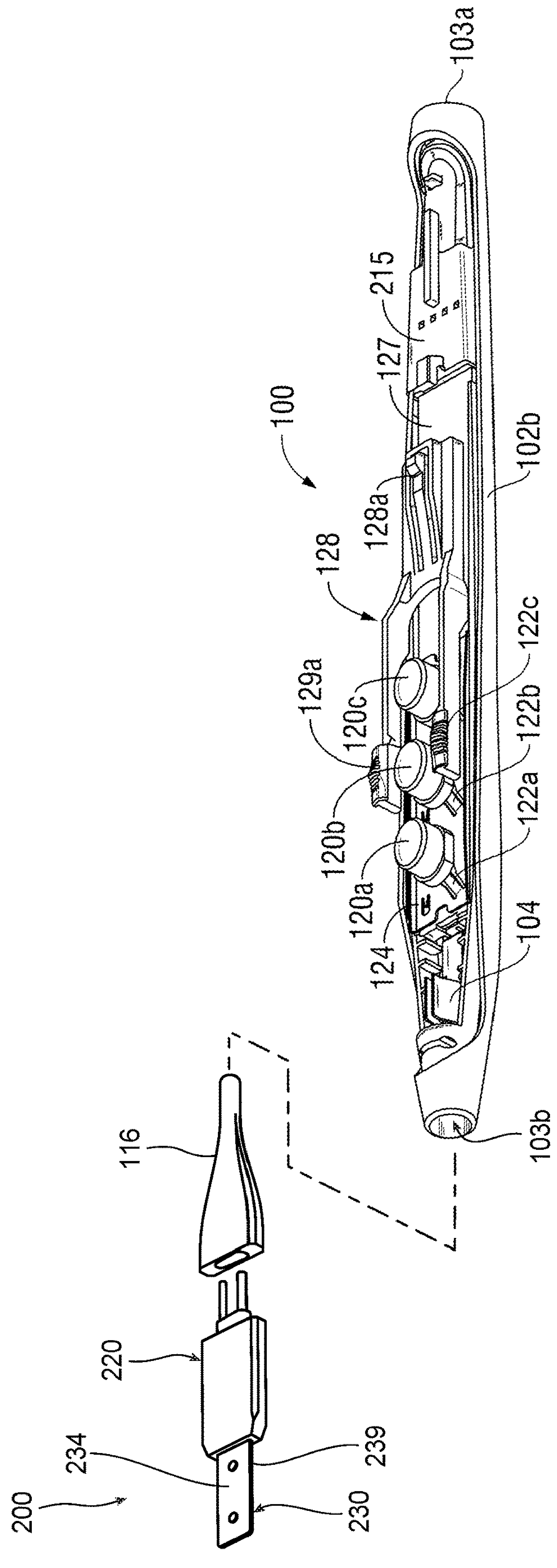
402
400
404
102a
406
102b
107
130b
102
129b
120c
130a
120b
129a
120a
104
100
"G"
"R"
112
116
220
239
200
234
112a
112b
216a
216b

Fig. 1A

Fig. 1B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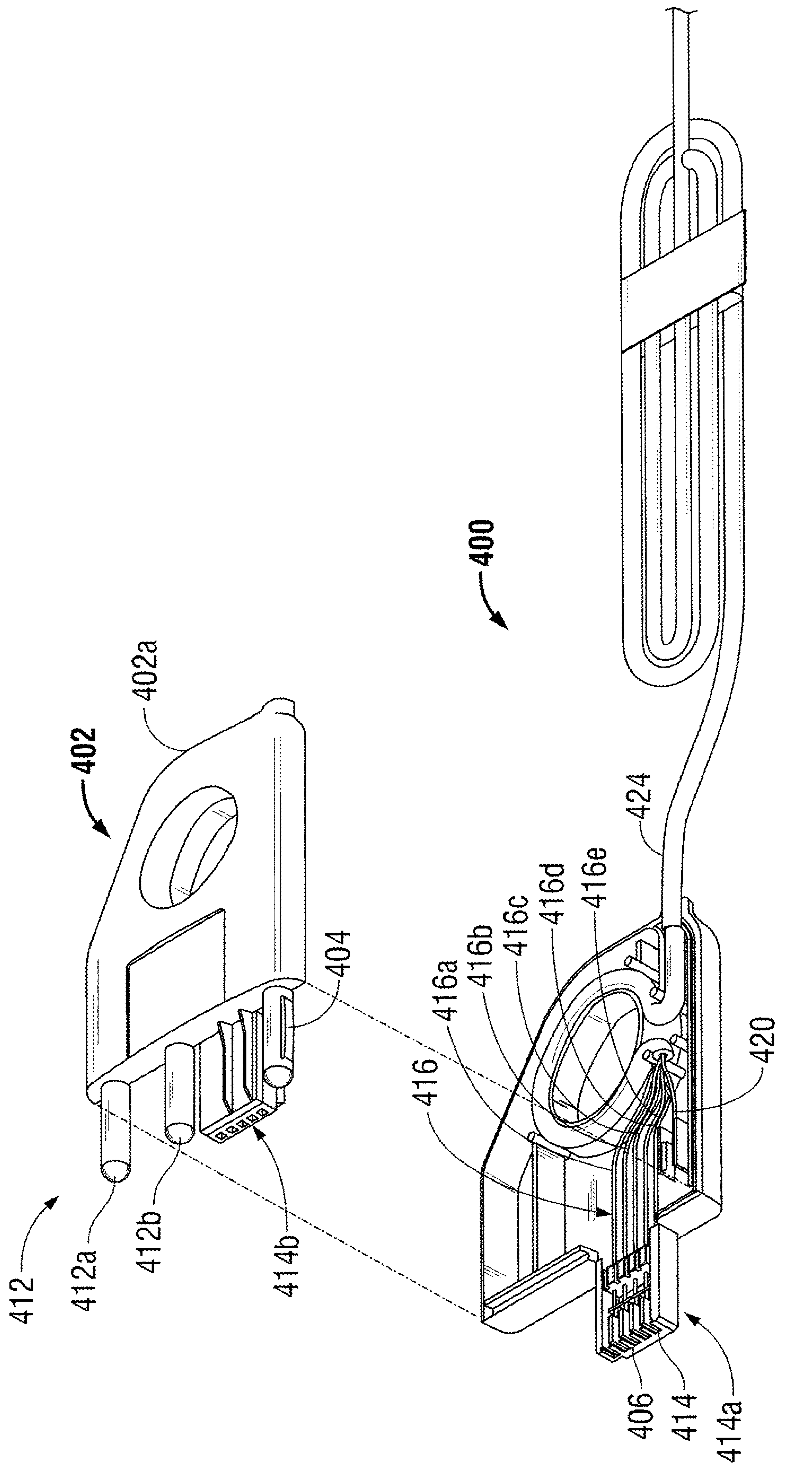
230

Fig. 2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402
402a
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412b
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416
416a
416b
416c
416d
416e
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424
406
414
414a

Fig. 3

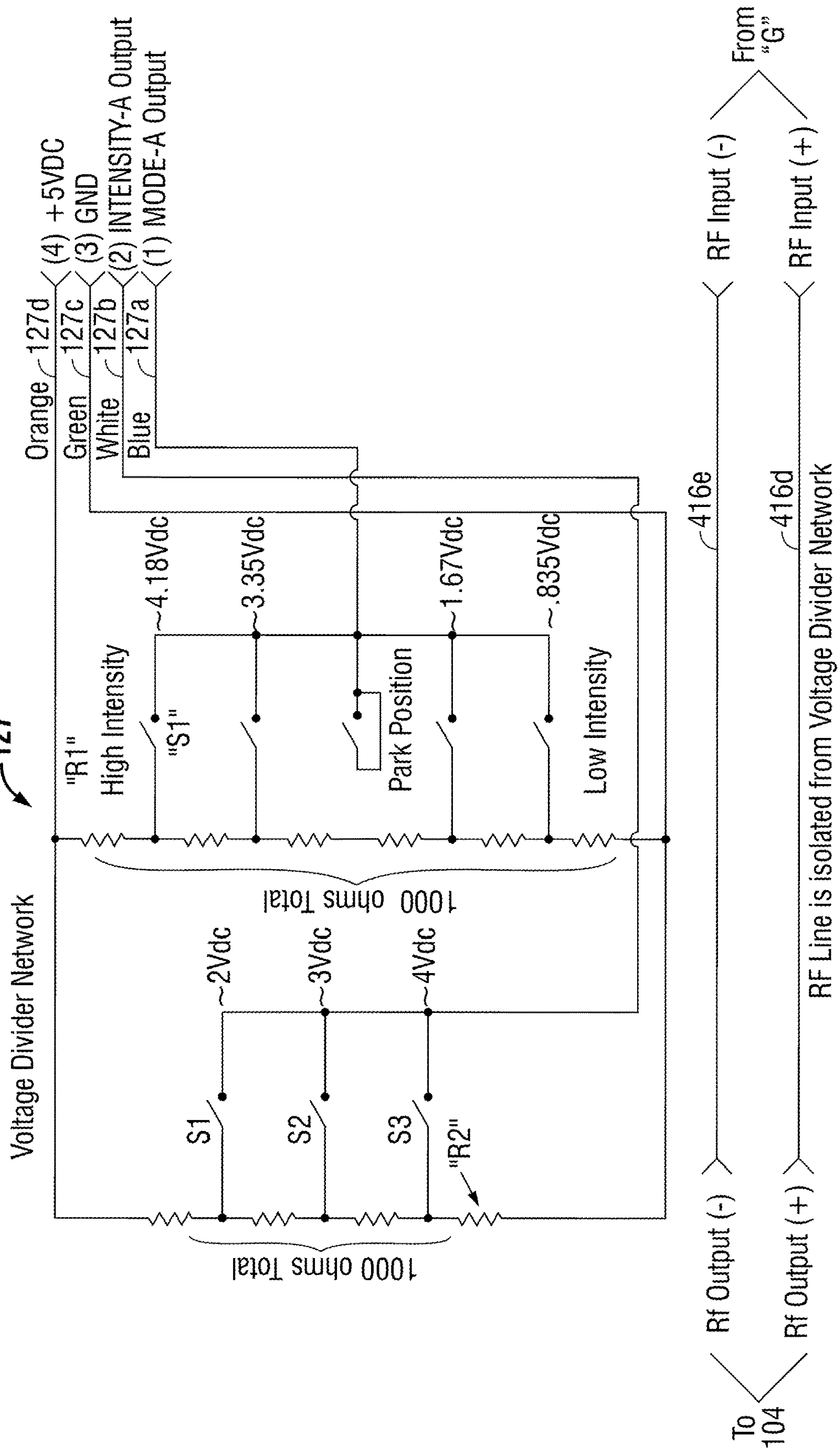

127
Voltage Divider Network
"R1"
High Intensity
"S1"
Park Position
Low Intensity
~4.18Vdc
~3.35Vdc
~1.67Vdc
~.835Vdc
1000 ohms Total
~2Vdc
~3Vdc
~4Vdc
S1
S2
S3
"R2"
1000 ohms Total
Orange 127d
Green 127c
White 127b
Blue 127a
(4) +5VDC
(3) GND
(2) INTENSITY-A Output
(1) MODE-A Output
416e
416d
RF Line is isolated from Voltage Divider Network
RF Input (-)
RF Input (+)
From "G"
Rf Output (-)
Rf Output (+)
To 104

Fig. 4

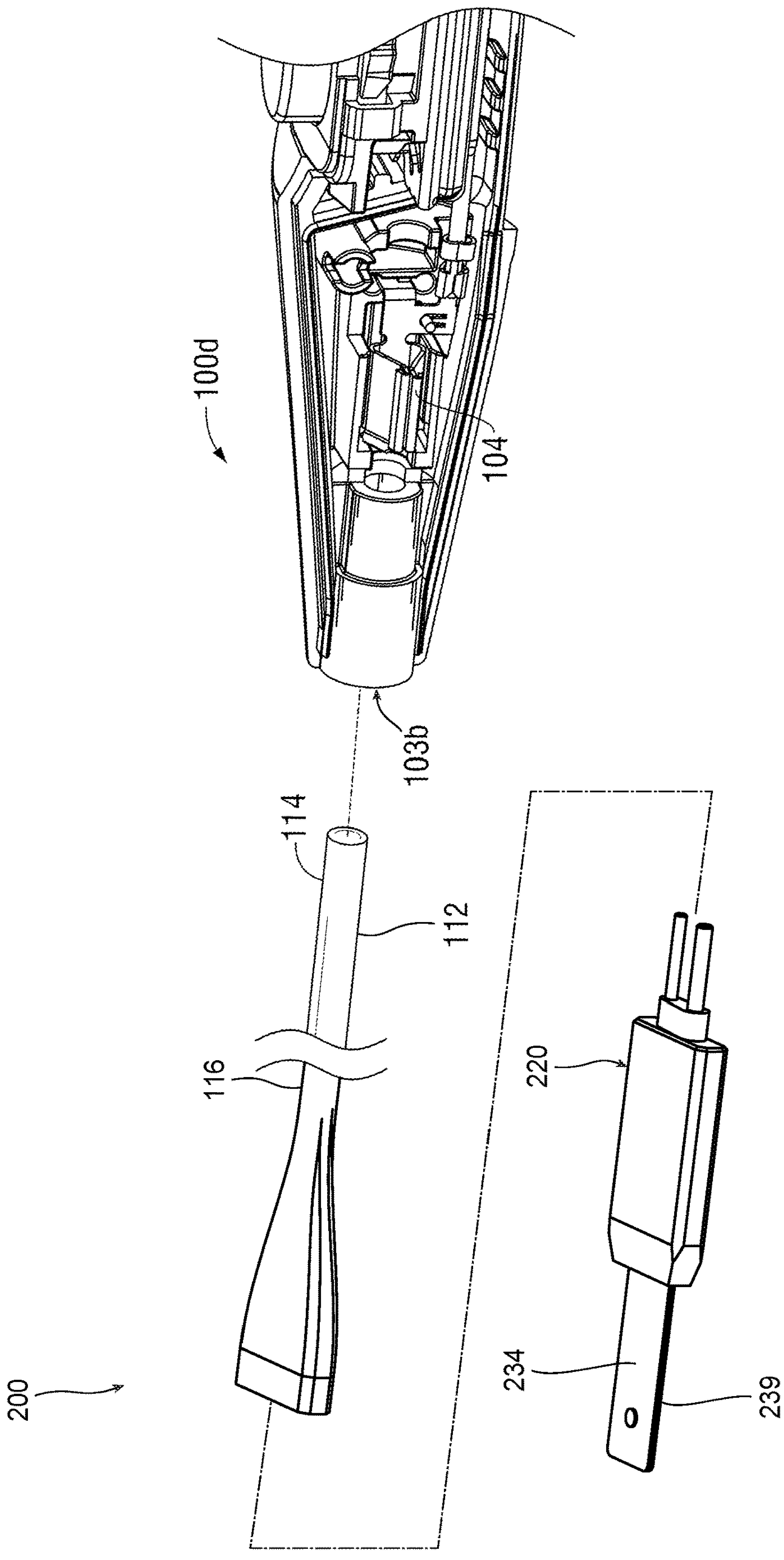


Fig. 5

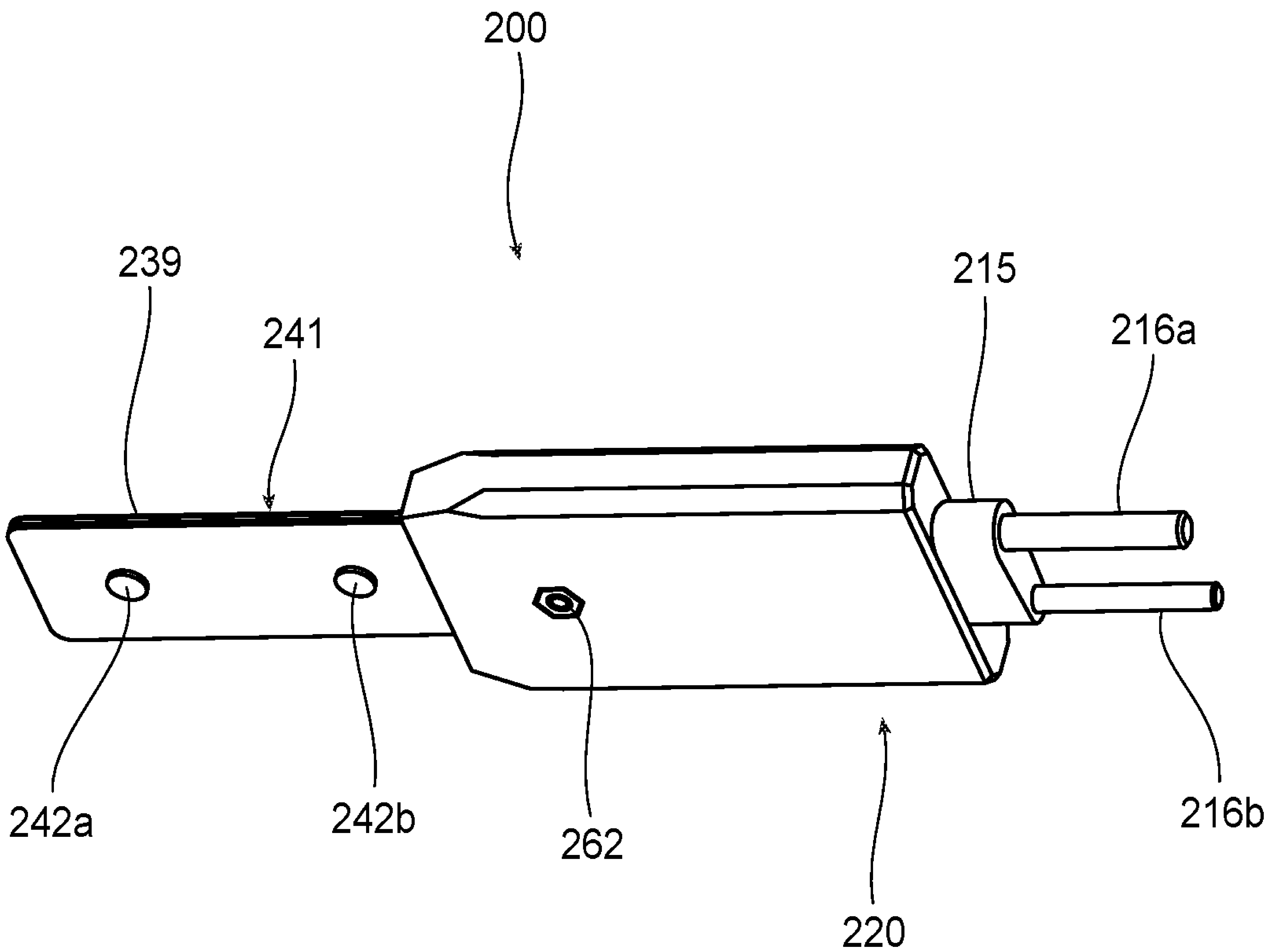
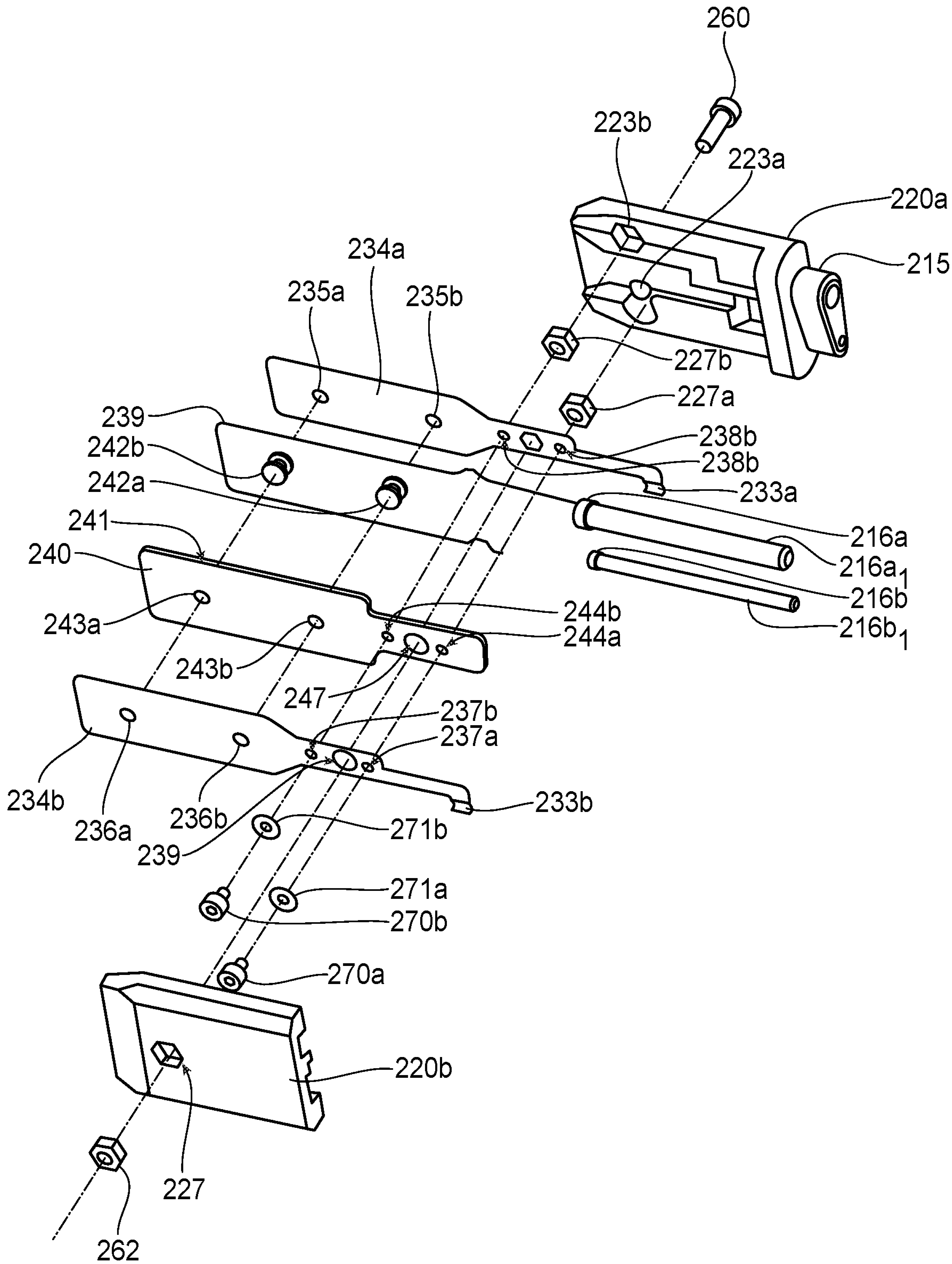


Fig. 6A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235a
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227a
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242b
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238b
242a
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216a
240
$216a_1$
216b
$216b_1$
244b
243a
244a
243b
247
237b
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239
271b
271a
270b
270a
220b
227
262

Fig. 6B

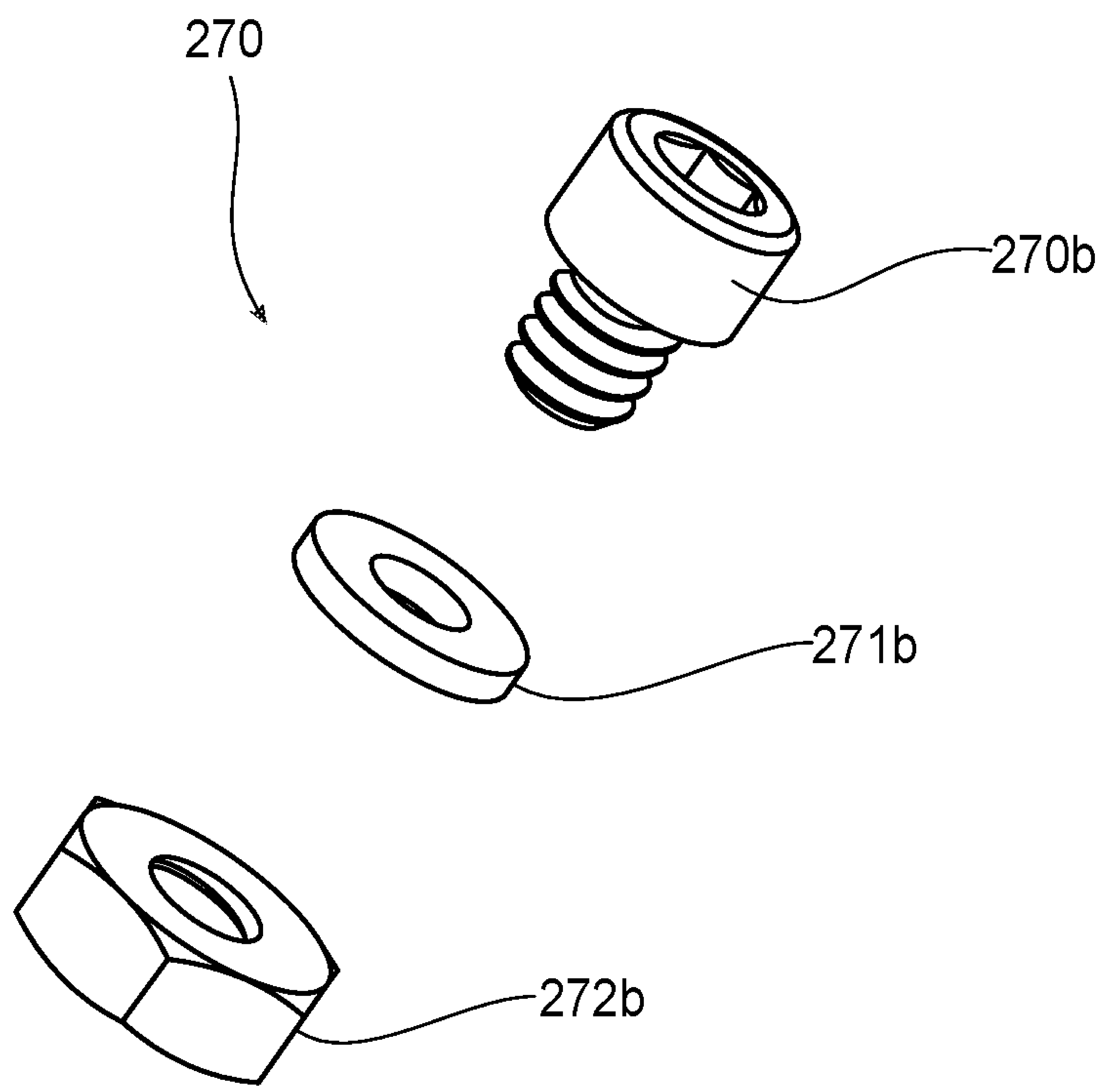
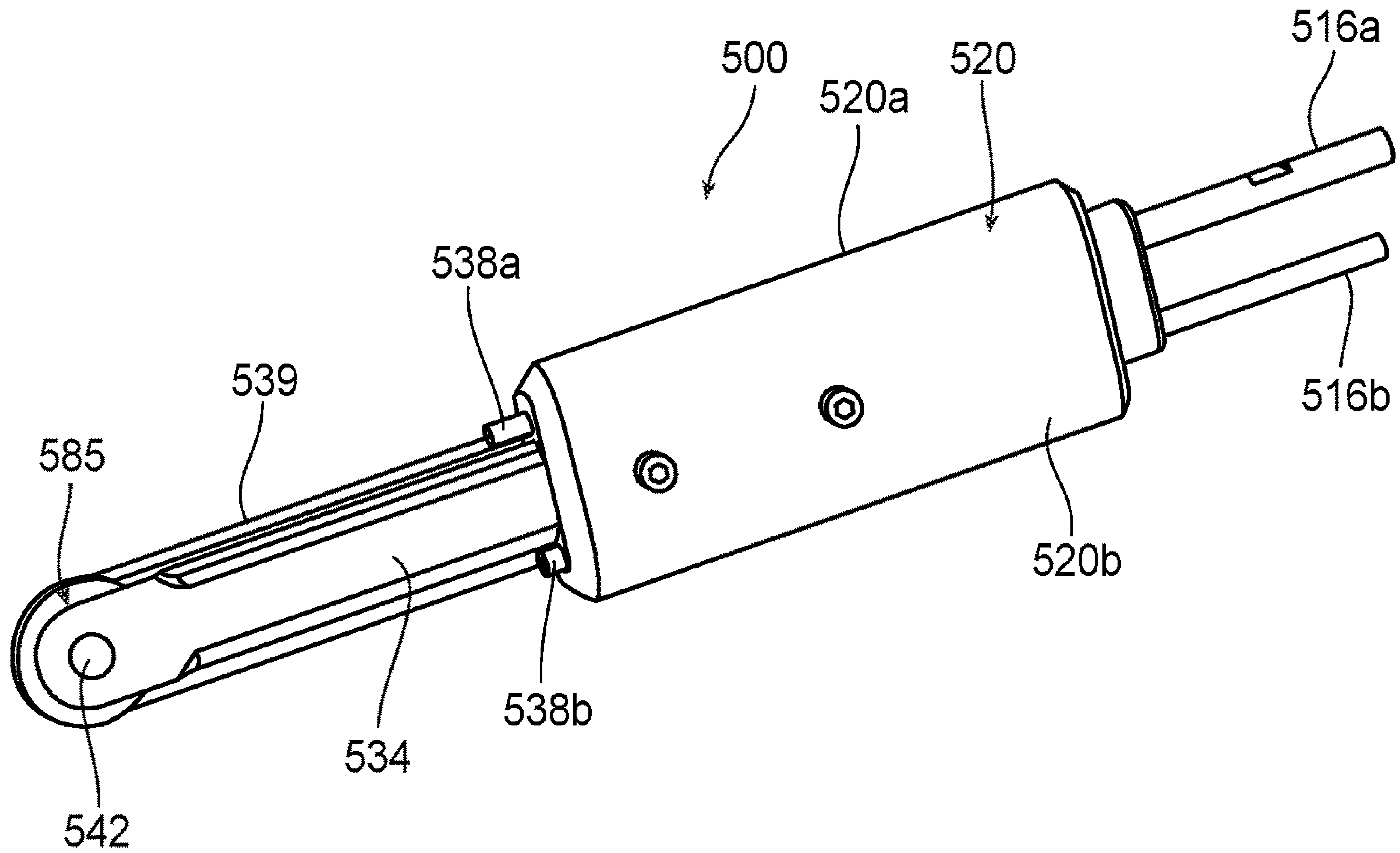


Fig. 6C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520a
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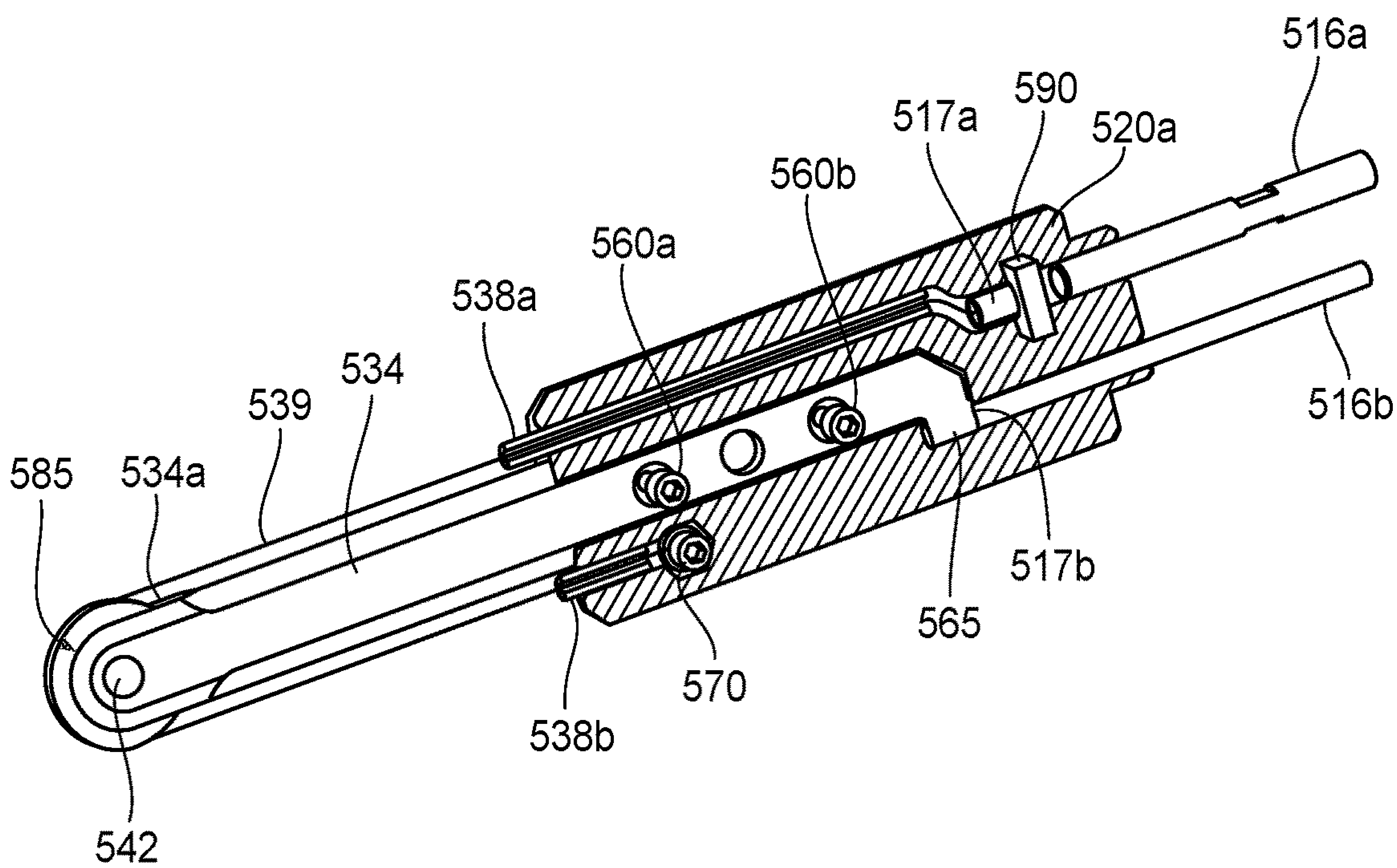
516a
538a
539
585
516b
520b
534
538b
542

Fig. 7A


516a
590
517a
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560b
560a
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534
539
585
534a
516b
517b
565
570
538b
542

Fig. 7B

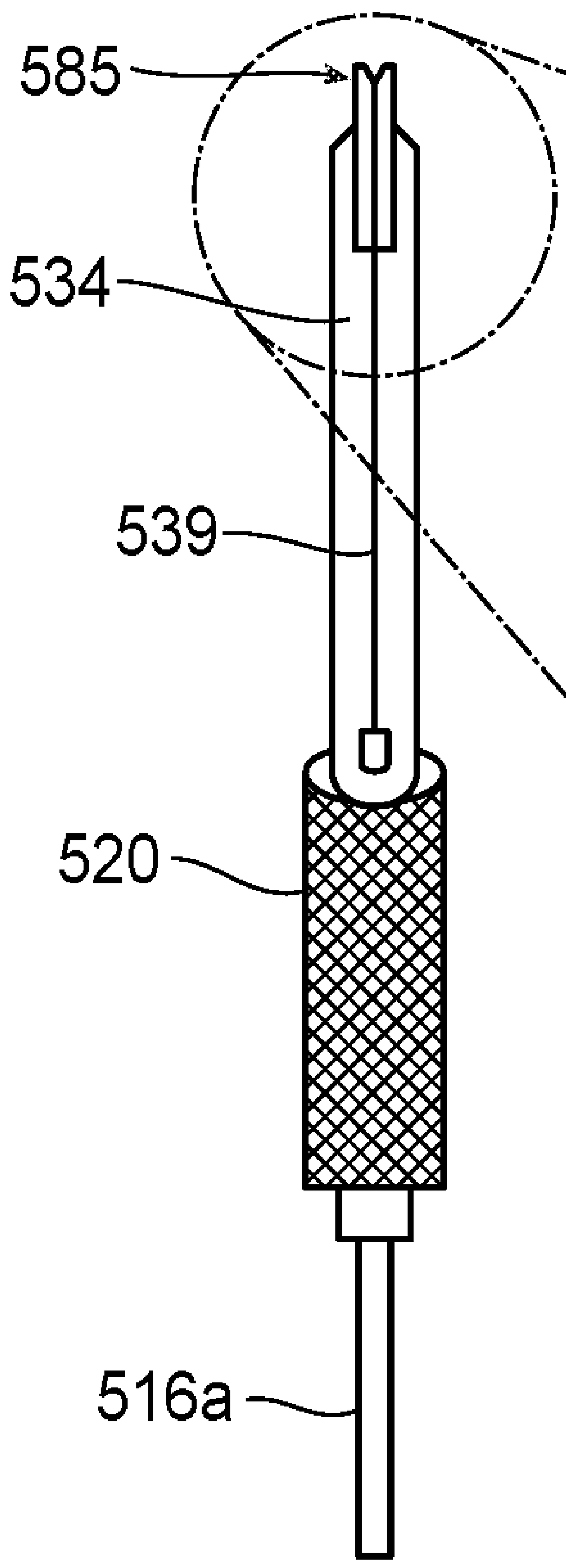


Fig. 7C

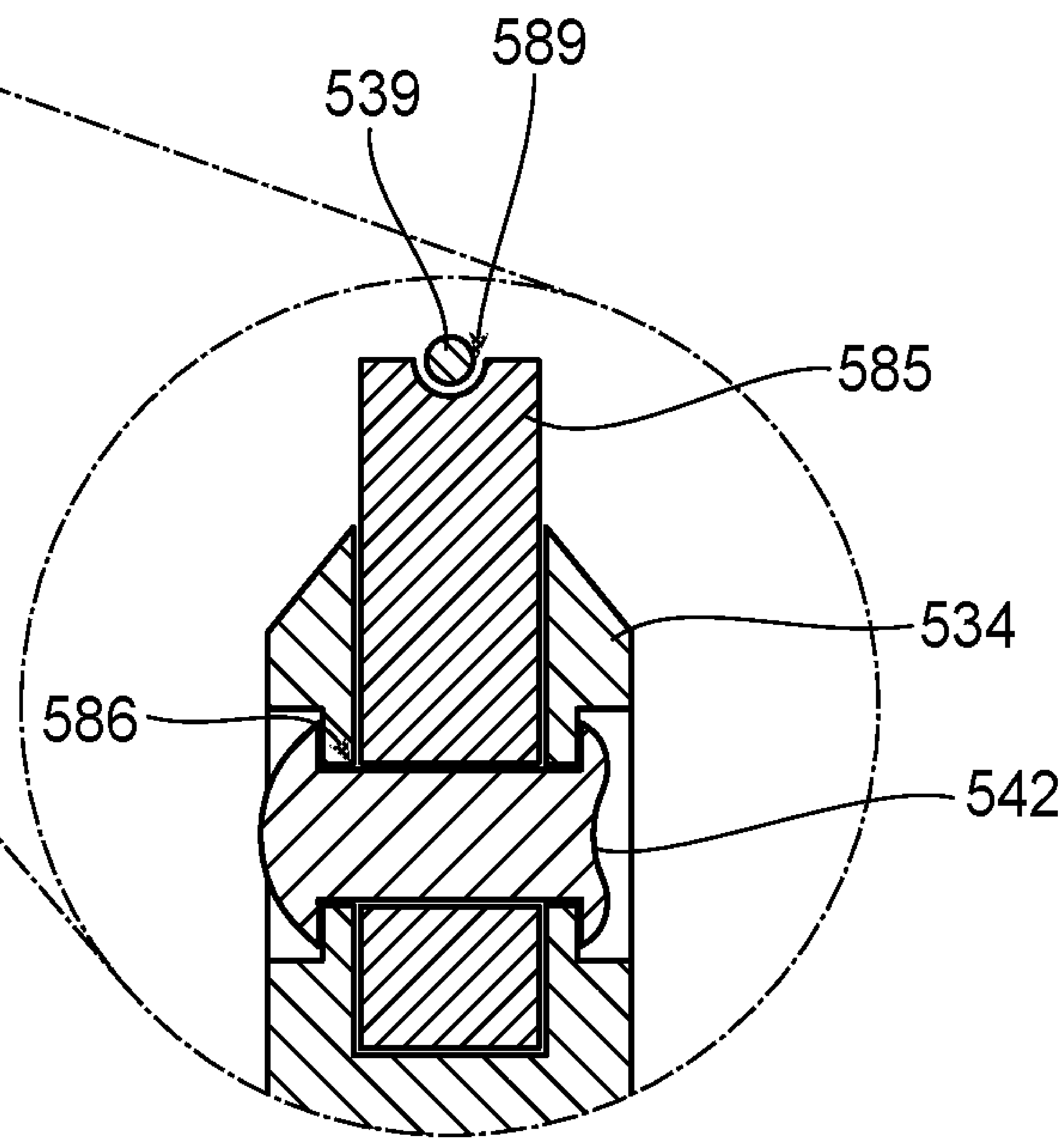
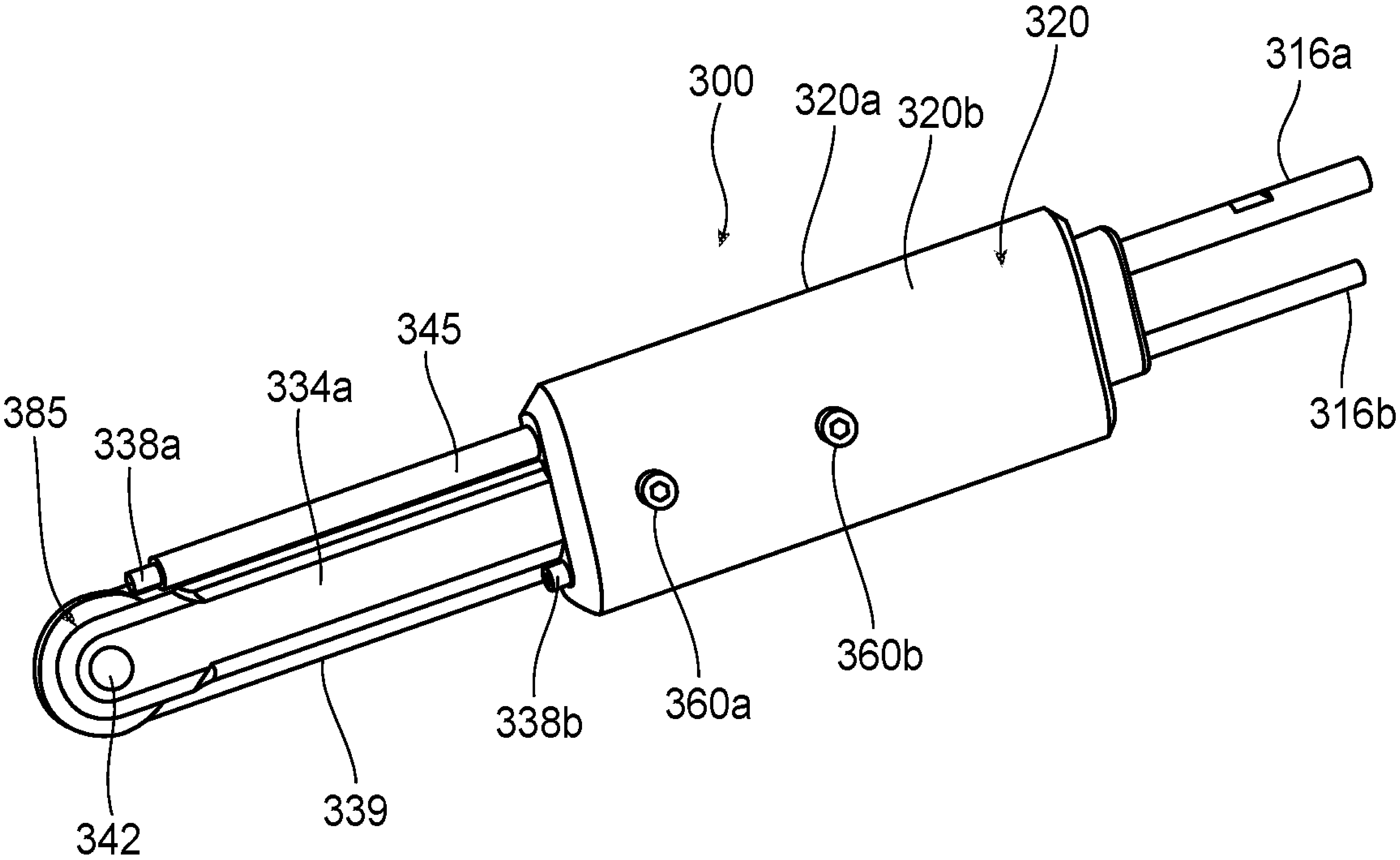


Fig. 7D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320b
320
316a
316b
345
334a
385
338a
338b
360a
360b
342
339

Fig. 8

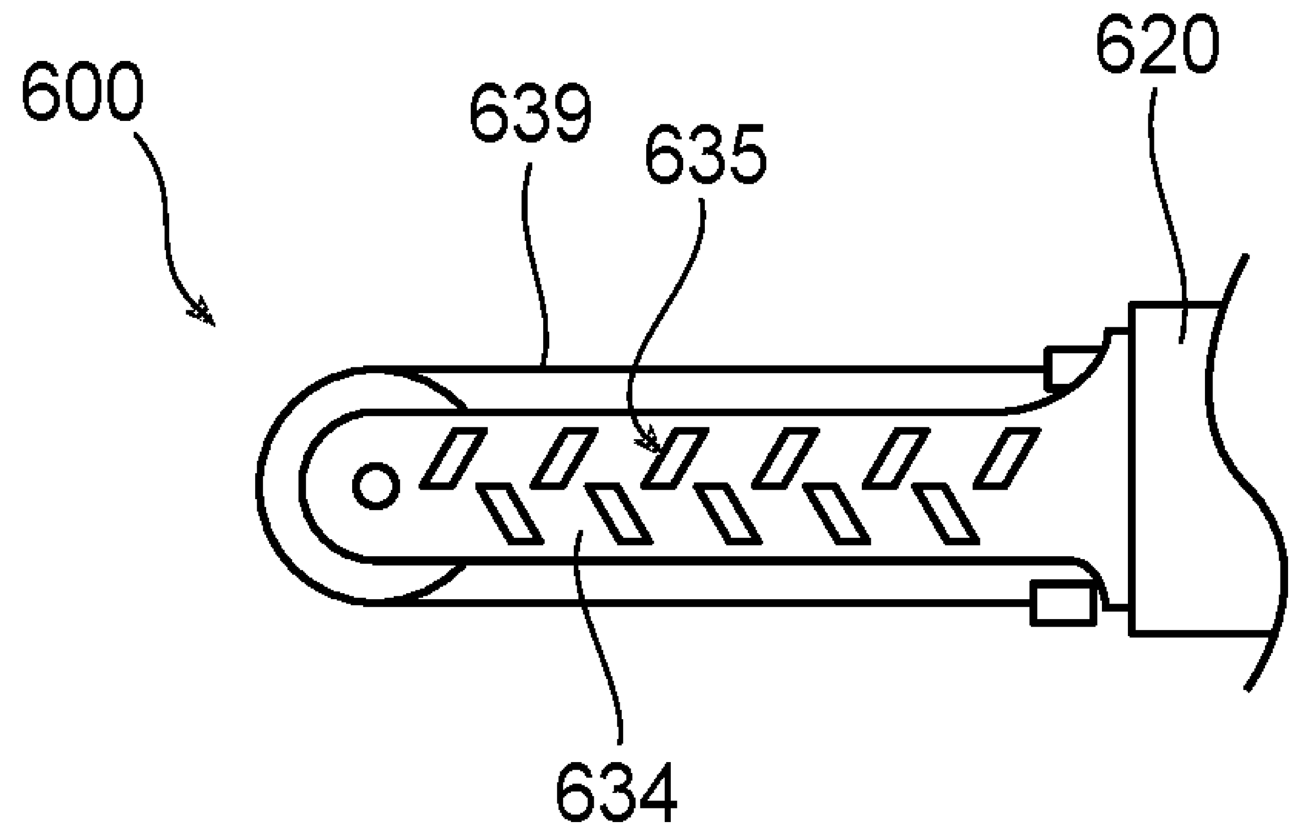
600
639
635
620
634

Fig. 9

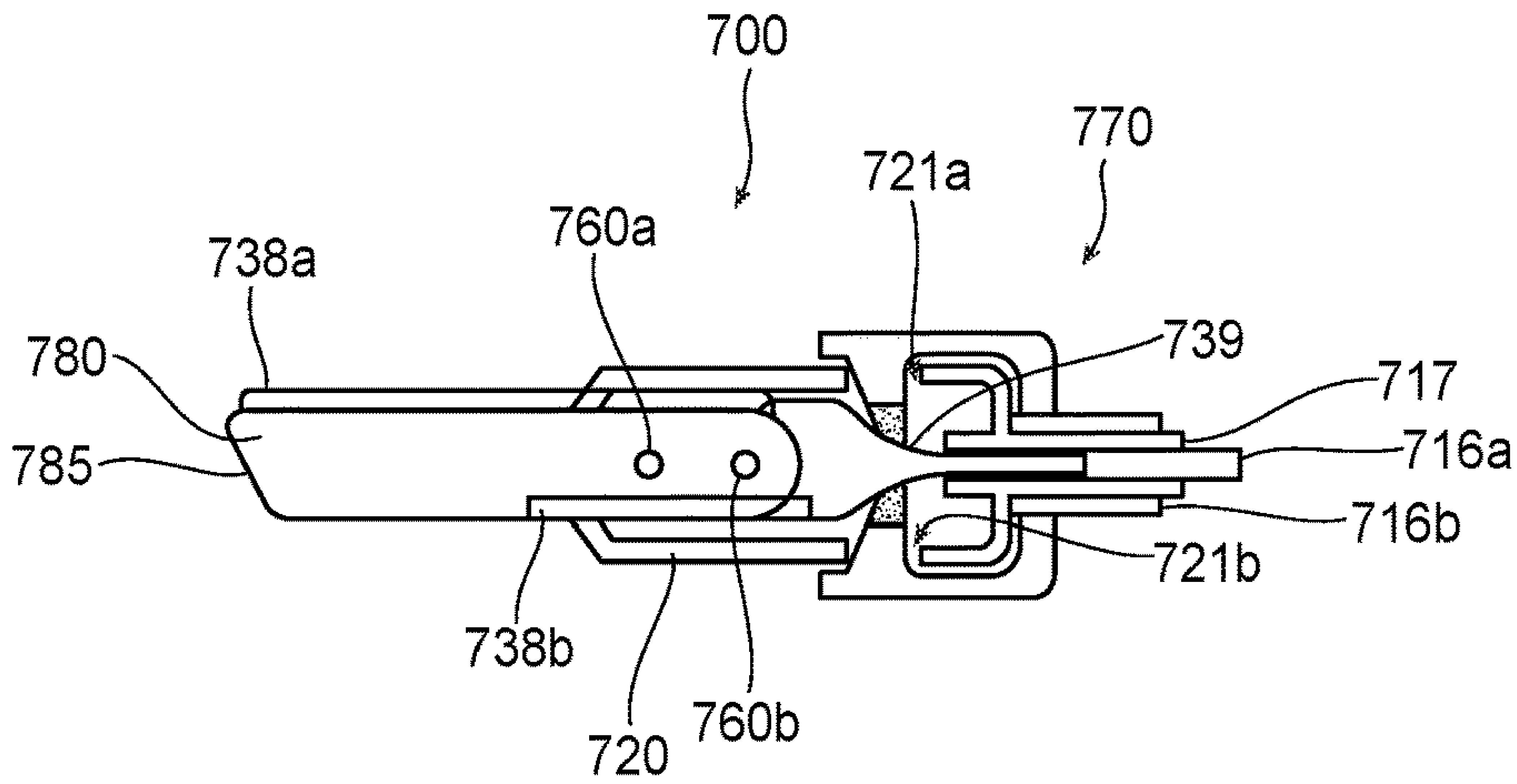

Fig. 10A

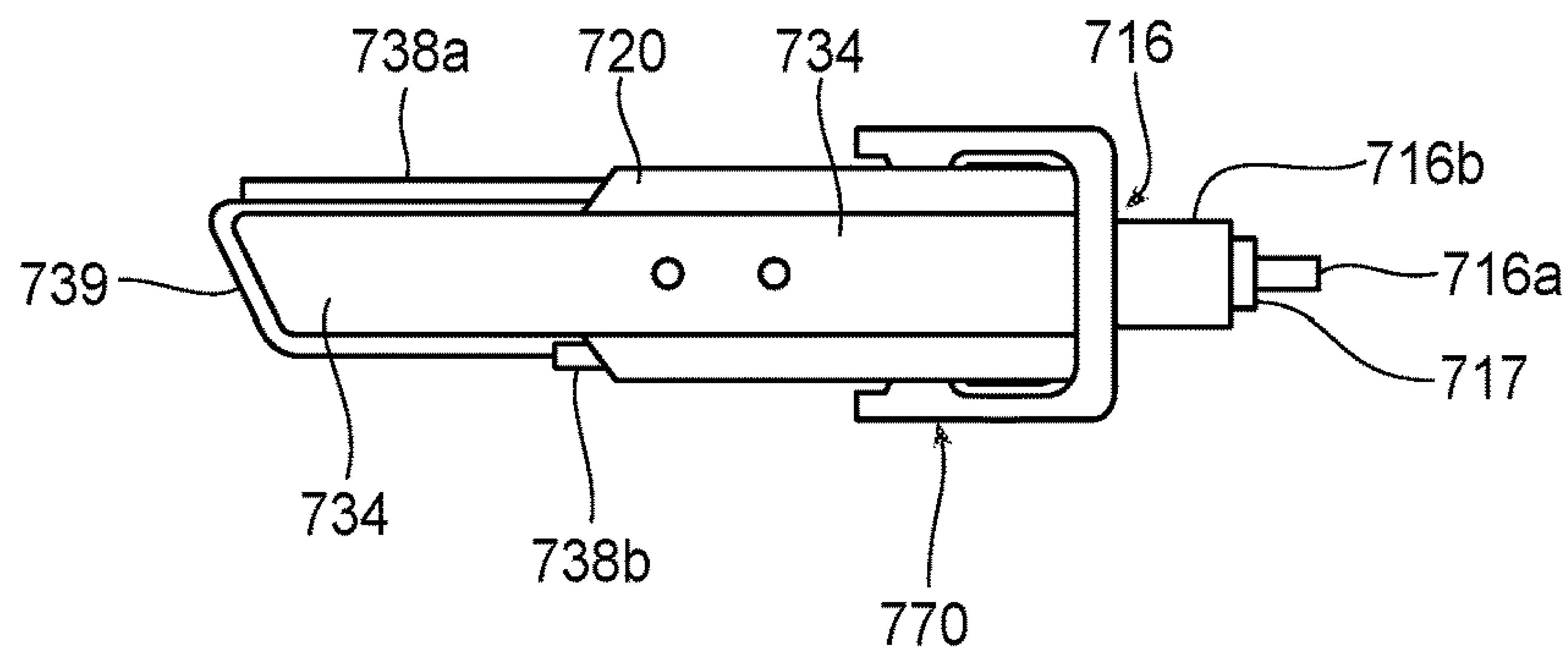

Fig. 10B

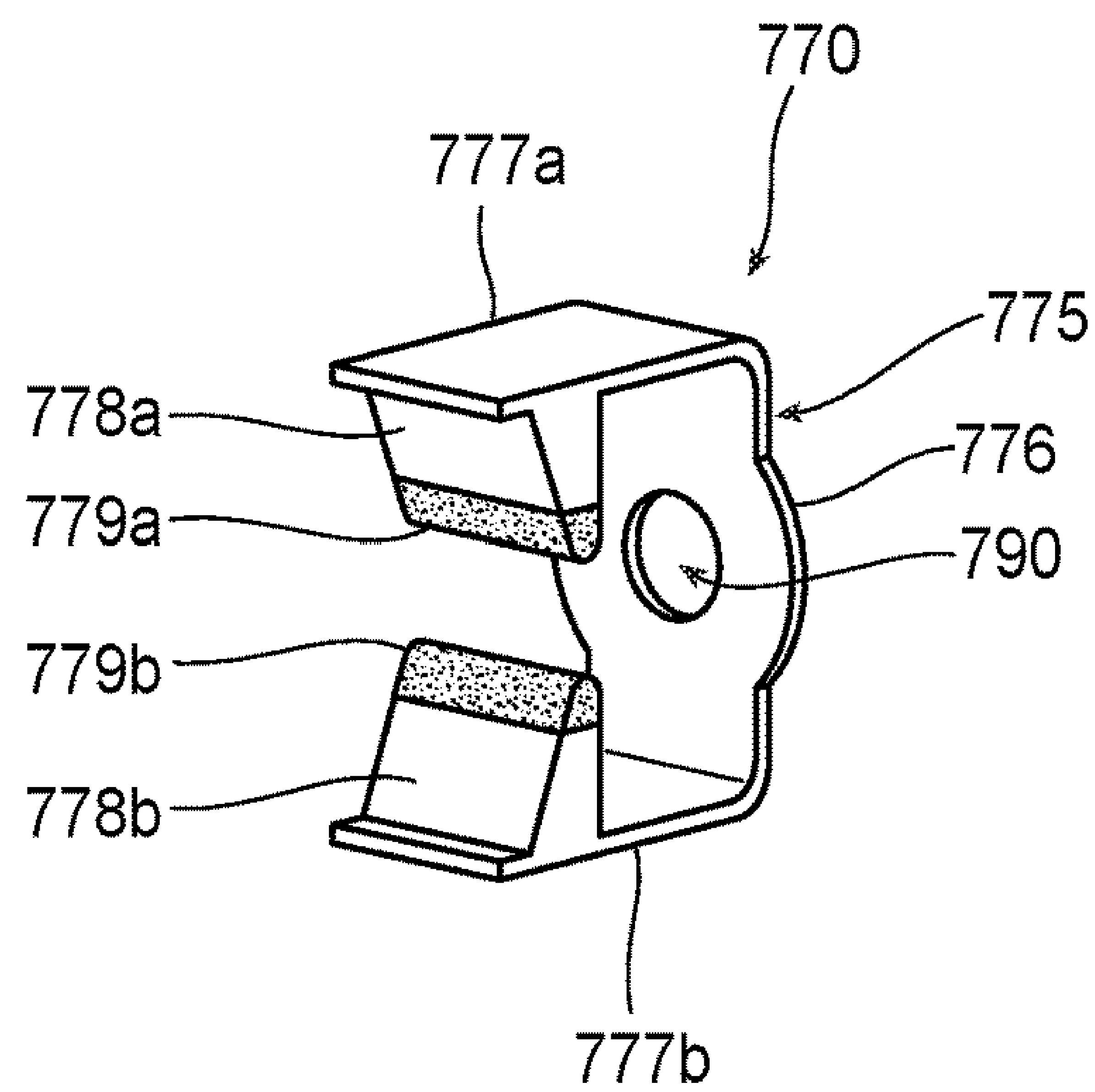

Fig. 10C

END EFFECTOR ASSEMBLY FOR BIPOLAR PENCIL

BACKGROUND

Technical Field

The present disclosure relates generally to electrosurgical instruments and, more particularly, to an electrosurgical bipolar pencil having a donut-style end effector assembly and a tensioning mechanism.

Background of Related Art

Electrosurgical instruments have become widely used by surgeons in recent years. Accordingly, a need has developed for equipment and instruments which are easy to handle, are reliable and are safe in an operating environment. By and large, most electrosurgical instruments are hand-held instruments, e.g., an electrosurgical pencil, which transfer radio-frequency (RF) electrical or electrosurgical energy to a tissue site. The electrosurgical energy is returned to the electrosurgical source via a return electrode pad positioned under a patient (i.e., a monopolar system configuration) or a smaller return electrode positionable in bodily contact with or immediately adjacent to the surgical site (i.e., a bipolar system configuration). The waveforms produced by the RF source yield a predetermined electrosurgical effect known generally as electrosurgical coagulation, electrosurgical sealing, electrosurgical cutting, and/or electrosurgical fulguration or, in some instances, an electrosurgical blend thereof.

In particular, electrosurgical fulguration includes the application of an electric spark to biological tissue, for example, human flesh or the tissue of internal organs, without significant cutting. The spark is produced by bursts of radio-frequency electrical or electrosurgical energy generated from an appropriate electrosurgical generator. Coagulation is defined as a process of desiccating tissue wherein the tissue cells are ruptured and dehydrated/dried. Electrosurgical cutting/dissecting, on the other hand, includes applying an electrical spark to tissue in order to produce a cutting, dissecting and/or dividing effect. Blending includes the function of cutting/dissecting combined with the production of a hemostasis effect. Meanwhile, sealing/hemostasis is defined as the process of liquefying the collagen in the tissue so that it forms into a fused mass.

As used herein the term "electrosurgical pencil" is intended to include instruments that have a handpiece which is attached to an active electrode and that is used to cauterize, coagulate and/or cut tissue. Typically, the electrosurgical pencil may be operated by a handswitch or a foot switch.

As mentioned above, the handpiece of the electrosurgical pencil is connected to a suitable electrosurgical energy source (e.g., generator) that produces the radio-frequency electrical energy necessary for the operation of the electrosurgical pencil. In general, when an operation is performed on a patient with an electrosurgical pencil in a monopolar mode, electrical energy from the electrosurgical generator is conducted through the active electrode to the tissue at the site of the operation and then through the patient to a return electrode. The return electrode is typically placed at a convenient place on the patient's body and is attached to the generator by a conductive material. Typically, the surgeon activates the controls on the electrosurgical pencil to select the modes/waveforms to achieve a desired surgical effect. Typically, the "modes" relate to the various electrical waveforms, e.g., a cutting waveform has a tendency to cut tissue, a coagulating wave form has a tendency to coagulate tissue, and a blend wave form tends to be somewhere between a cut and coagulate wave from. The power or energy parameters are typically controlled from outside the sterile field which requires an intermediary like a circulating nurse to make such adjustment.

When an operation is performed on a patient with an electrosurgical pencil in a bipolar mode, the electrode face includes at least one pair of bipolar electrodes and electrical energy from the electrosurgical generator is conducted through tissue between the pair of bipolar electrodes.

A typical electrosurgical generator has numerous controls for selecting an electrosurgical output. For example, the surgeon can select various surgical "modes" to treat tissue: cut, blend (blend levels 1-3), low cut, desiccate, fulgurate, spray, etc. The surgeon also has the option of selecting a range of power settings typically ranging from 1-300 W. As can be appreciated, this gives the surgeon a great deal of variety when treating tissue. Surgeons typically follow preset control parameters and stay within known modes and power settings and electrosurgical pencils include simple and ergonomically friendly controls that are easily selected to regulate the various modes and power settings

Electrosurgical instruments are typically configured such that power output can be adjusted without the surgeon having to turn his or her vision away from the operating site and toward the electrosurgical generator.

SUMMARY

As used herein, the term "distal" refers to the portion that is described which is further from a user, while the term "proximal" refers to the portion that is being described which is closer to a user. The terms "substantially" and "approximately," as utilized herein, account for industry-accepted material, manufacturing, measurement, use, and/or environmental tolerances. Further, any or all of the aspects and features described herein, to the extent consistent, may be used in conjunction with any or all of the other aspects and features described herein.

Provided in accordance with aspects of the present disclosure is an electrode assembly for an electrosurgical instrument that includes a housing having an active electrical connector and a return electrical connector configured to operably engage a distal end of an electrosurgical instrument shaft. The housing encapsulates an elongated return electrode and a pair of insulative tubes configured to house a wire-like active electrode. The elongated return electrode includes a clevis at a distal end thereof and operably engages to the return electrical connector at a proximal end thereof. The wire-like active electrode operably engages at one end thereof to the active electrical connector. A donut-like insulator operably engages to the clevis of the elongated return electrode, the donut-like ceramic insulator configured to support the wire-like active electrode therearound. A tensioning mechanism is configured to operably engage an opposite end of the wire-like active electrode and tension the wire-like active electrode about the donut-like insulator during assembly.

In aspects according to the present disclosure, the tensioning mechanism includes at least one bolt, at least one nut and at least one washer, the at least one washer configured to crimp the wire-like active electrode against the at least one respective nut to vary the tensioning of the wire-like active electrode during assembly. In other aspects according to the present disclosure, the at least one washer is at least one of a spring washer or a wave washer.

In aspects according to the present disclosure, the proximal end of the return electrode is threadably engaged to the return electrical connector. In other aspects according to the present disclosure, the donut-like insulator is secured to the clevis of the elongated return electrode by a rivet. In yet other aspects according to the present disclosure, the donut-like insulator includes a groove defined therein configured to seat the wire-like active electrode as the wire-like active electrode transitions therearound. In aspects according to the present disclosure, the active electrical connector operably secures to the housing via a square-shaped nut.

Provided in accordance with aspects of the present disclosure is an electrode assembly for an electrosurgical instrument that includes a housing configured to operably receive a distal end of an electrosurgical instrument shaft. The housing includes a pair of apertures defined on opposite sides thereof. The housing encapsulates an insulative core sandwiched between a pair of return electrodes, the insulative core including a slot defined about a periphery thereof configured to at least partially receive a wire-like active electrode. The wire-like active electrode is configured to connect at both ends thereof to an active electrical connector operably engaged to the housing and the pair of return electrodes is configured to connect to a return electrical connector operably engaged to the housing. The active and return electrical connectors are adapted to connect to opposite polarities of an electrosurgical generator. A tensioning mechanism is configured to tension the active electrode about the insulative core during assembly. The tensioning mechanism including a C-shaped clip having a central web supporting a pair of resilient arms on either end thereof. The arms each including a finger projecting inwardly therefrom, the fingers of the C-shaped clip are configured to be received within the apertures defined in the housing upon engagement of the C-shaped clip on the housing. The fingers cooperate to engage the wire-like active electrode on opposite ends thereof to tension the wire-like active electrode about the insulative core.

In aspects according to the present disclosure, the fingers include an anti-slip material disposed thereon. In other aspects according to the present disclosure, the active electrical connector and the return electrical connector are concentrically disposed within a single electrical connector. In yet other aspects according to the present disclosure, the C-shaped clip includes an aperture defined therein configured to receive the single electrical connector.

In aspects according to the present disclosure, the tension of the C-shaped clip is variable depending on the length of at least one the fingers. In other aspects according to the present disclosure, the tension of the C-shaped clip is variable depending on the resiliency of at least one of the arms.

In aspects according to the present disclosure, the wire-like active electrode is housed in an insulative tube on one side of the insulative core. In aspects according to the present disclosure, at least a portion of the active electrode remains exposed to treat tissue when seated within the slot defined in the insulative core.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention, and together with a general description of the invention given above, and the detailed description of the embodiments given below, serve to explain the principles of the invention.

FIG. **1**A is a perspective view of an electrosurgical system including an electrosurgical pencil including a housing having a shaft extending therefrom with an end effector attached to a distal end thereof, the end effector configured for bipolar resection in accordance with an embodiment of the present disclosure;

FIG. **1**B is a greatly enlarged view of a proximal end of the end effector and the distal end of the shaft of the electrosurgical pencil housing;

FIG. **2** is a front, top perspective view of the electrosurgical pencil of FIG. **1**, with a top-half shell of the housing removed;

FIG. **3** is a perspective view of the plug assembly of FIG. **1**, with a top-half shell section removed therefrom;

FIG. **4** is a schematic illustration of the voltage divider network of the present disclosure;

FIG. **5** is a partial, cross-sectional view of an end effector assembly of an electrosurgical pencil, in accordance with an embodiment of the present disclosure;

FIG. **6**A is an enlarged, top, perspective view of the end effector assembly of the present disclosure;

FIG. **6**B is an enlarged, top, exploded view of the end effector assembly of FIG. **6**A;

FIG. **6**C is a greatly enlarged, exploded view of a tensioning mechanism for use with the end effector assembly according to the present disclosure;

FIGS. **7**A-**7**D are various views of another embodiment of an end effector assembly in accordance with the present disclosure;

FIG. **8** is a top perspective view of another embodiment of an end effector assembly in accordance with the present disclosure;

FIG. **9** is a side view of another embodiment of an end effector assembly in accordance with the present disclosure; and

FIGS. **10**A-**10**C are various views of an end effector assembly including a tensioning mechanism for use with any of the disclosed end effector assemblies disclosed herein.

DETAILED DESCRIPTION

Particular embodiments of the presently disclosed electrosurgical pencil configured for bipolar resection are described in detail with reference to the drawing figures wherein like reference numerals identify similar or identical elements. As used herein, the term "distal" refers to that portion which is further from the user while the term "proximal" refers to that portion which is closer to the user or clinician. The term "leading edge" refers to the most forward edge with respect to the direction of travel while the term "trailing edge" refers to the edge opposite the leading edge with respect to the direction of travel.

FIGS. **1**A-**1**B sets forth a perspective view of an electrosurgical system including an electrosurgical pencil **100** constructed for bipolar resection in accordance with one embodiment of the present disclosure. While the following description is directed towards electrosurgical pencils for bipolar resection, the features and concepts (or portions thereof) of the present disclosure may be applied to any electrosurgical type instrument, e.g., forceps, suction coagulators, vessel sealers, wands, etc. The construction, functionality and operation of electrosurgical pencils, with respect to use for bipolar resection, is described herein. Further details of the electrosurgical pencil are provided in commonly-owned U.S. Pat. No. 7,156,842 to Sartor et al.

As seen in FIGS. **1**A, **1**B and **2**, electrosurgical pencil **100** includes an elongated housing **102** having a top-half shell portion **102***a* and a bottom-half shell portion **102***b*. The elongated housing **102** includes a distal opening **103***b*, through which a shaft **112** extends, and a proximal opening **103***a*, through which connecting wire **224** (see FIG. **1**A) extends. Top-half shell portion **102***a* and bottom-half shell portion **102***b* may be bonded together using any suitable method, e.g., sonic energy, adhesives, snap-fit assemblies, etc.

Electrosurgical pencil **100** further includes a shaft receptacle **104** disposed at a distal end **103***b* of housing **102** that is configured to receive the shaft **112** of a selectively removable end effector assembly **200**. Electrode assembly **200** is configured to electrically connect to generator "G" through various electrical conductors (not shown) formed in the shaft **112**, elongated housing **102**, connecting wire **224** and plug assembly **400**. Generator "G" may be incorporated into the elongated housing **102** and powered by an internal energy supply, e.g., battery or other energy storage device, fuel cell or other energy generation device or any other suitable portable power source.

Shaft **112** is selectively retained by shaft receptacle **104** disposed in housing **102**. Shaft **112** may include a plurality of conductive traces or wires along the length of the shaft **112**. The conductive traces or wires may be fabricated from a conductive type material, such as, for example, stainless steel, or shaft may be coated with an electrically conductive material. Shaft receptacle **104** is fabricated from electrically conductive materials or includes electrically conductive contacts configured to couple with the plurality of conductive traces or wires of the shaft **112**. Shaft receptacle **104** is electrically connected to voltage divider network **127** (FIGS. **2** and **4**) as explained in more detail below. Conductive traces or wires of the shaft electrically connect to the electrode assembly as explained in more detail below.

As seen in FIG. **1**A, electrosurgical pencil **100** may be coupled to a conventional electrosurgical generator "G" via a plug assembly **400** (see FIG. **3**), as will be described in greater detail below.

For the purposes herein, the terms "switch" or "switches" includes electrical actuators, mechanical actuators, electromechanical actuators (rotatable actuators, pivotable actuators, toggle-like actuators, buttons, etc.) or optical actuators.

Electrosurgical pencil **100** includes at least one activation switch, and may include three activation switches **120***a*-**120***c*, each of which extends through top-half shell portion **102***a* of elongated housing **102**. Each activation switch **120***a*-**120***c* is operatively supported on a respective tactile element **122***a*-**122***c* provided on a switch plate **124**, as illustrated in FIG. **2**. Each activation switch **120***a*-**120***c* controls the transmission of RF electrical energy supplied from generator "G" to bipolar electrodes **138** on electrode face **105** of electrode body **112**.

More particularly, switch plate **124** is positioned on top of a voltage divider network **127** (hereinafter "VDN **127**") such that tactile elements **122***a*-**122***c* are operatively associated therewith. VDN **127** (e.g., here shown in FIG. **2** as a film-type potentiometer) forms a switch closure. For the purposes herein, the term "voltage divider network" relates to any known form of resistive, capacitive or inductive switch closure (or the like) which determines the output voltage across a voltage source (e.g., one of two impedances) connected in series. A "voltage divider" as used herein relates to a number of resistors connected in series which are provided with taps at certain points to make available a fixed or variable fraction of the applied voltage. Further details of electrosurgical pencil control are provided in above-mentioned U.S. Pat. No. 7,503,917 to Sartor et al.

In use, depending on which activation switch **120***a*-**120***c* is depressed a respective tactile element **122***a*-**122***c* is pressed into contact with VDN **127** and a characteristic signal is transmitted to electrosurgical generator "G" via control wires **416** (see FIG. **3**). In one embodiment, three control wires **416***a*-**416***c* (one for each activation switch **120***a*-**120***c*, respectively) are provided. Control wires **416***a*-**416***c* are electrically connected to switches **120***a*-**120***c* via a control terminal **215** (see FIG. **2**) which is operatively connected to VDN **127**. By way of example only, electrosurgical generator "G" may be used in conjunction with the device wherein generator "G" includes a circuit for interpreting and responding to the VDN **127** settings.

Activation switches **120***a*, **120***b*, **120***c* are configured and adapted to control the mode and/or "waveform duty cycle" to achieve a desired surgical intent. For example, a first activation switch **120***a* can be set to deliver a characteristic signal to electrosurgical generator "G" which, in turn, transmits a duty cycle and/or waveform shape that produces a first desirable resection effect. Meanwhile, second activation switch **120***b* can be set to deliver a characteristic signal to electrosurgical generator "G" which, in turn, transmits a duty cycle and/or waveform shape that produces a second desirable resection effect.

Finally, third activation switch **120***c* can be set to deliver a characteristic signal to electrosurgical generator "G" which, in turn, transmits a duty cycle and/or waveform shape that produces a third electrosurgical effect/function. Desirable resection effects may include a mode for bipolar coagulation and/or cauterization with an undeployed blade, a mode for bipolar resection with a partially deployed blade, a mode for bipolar resection with a fully deployed blade, a mode for monopolar resection and a mode for resection with blended energy delivery (monopolar and bipolar modes), as will be described in greater detail hereinbelow.

As seen in FIG. **3**, fourth and fifth wires (e.g., first RF line **416***d* and second RF line **416***e*) are provided and electrically connect to respective active and return electrodes **239**, **234** respectively, of the end effector assembly **200** (or end effector assembly **300**, **500** as explained in more detail below with respect to FIGS. **7**A-**8**). Since first RF line **416***d* and second RF line **416***e* are directly connected to the end effector assembly **200** first RF line **416***d* and second RF line **416***e* bypass the VDN **127** and are isolated from VDN **127** and control wires **416***a*-**416***c*. By directly connecting the first RF line **416***d* and second RF line **416***e* to the end effector assembly **200** (or end effector assembly **300**, **500** as explained in more detail below) and isolating the VDN **127** from the RF energy transmission, the electrosurgical current does not flow through VDN **127**. This in turn, increases the longevity and life of VDN **127** and/or activation switches **120***a*, **120***b*, **120***c*.

With reference to FIG. **4**, VDN **127** is shown and includes a first transmission line **127***a* configured to operate the various modes of electrosurgical pencil **100**; a second transmission line **127***b* configured to operate the various intensities of electrosurgical pencil **100**; a third transmission line **127***c* configured to function as a ground for VDN **127**; and a fourth transmission line **127***d* which transmits up to about +5 volts to VDN **127**.

First RF line **416***d* and second RF line **416***e* are isolated from or otherwise completely separate from VDN **127**. In particular, first RF line **416***d* and second RF line **416***e* extends directly from the RF input or generator "G" to the active electrode and return electrodes of the end effector assembly **200** (or end effector assembly **300**, **500** as explained in more detail below).

By way of example only, VDN **127** may include a plurality of resistors "R1" (e.g., six resistors), connected in a first series between third transmission line **127***c* and fourth transmission line **127***d*. The first series of resistors "R1" may combine to total about 1000 ohms of resistance. The first series of resistors "R1" are each separated by a first set of switches "S1". Each switch of the first set of switches "S1" may be electrically connected between adjacent resistors "R1" and first transmission line **127***a* of VDN **127**. In operation, depending on which switch or switches of the first set of switches "S1" is/are closed, a different mode of operation for electrosurgical pencil **100** is activated.

Resection may be performed with electrosurgical energy including waveforms having a duty cycle from about 10% to about 100%. The dual effect of coagulating and cauterizing, as described herein, may be performed with a waveform having a duty cycle from about 10% to about 100%. To increase the depth of coagulation may require a waveform with a duty cycle from about 50% to 100%. It is important to note that these percentages are approximated and may be customized to deliver the desired surgical effect for various tissue types and characteristics.

In one embodiment, the waveforms provided to the bipolar electrosurgical pencil **100** may be dynamically controlled by the generator "G". For example, the mode of operation provided by switches **S1**, **S2**, **S3** may indicate a range of operation for the generator "G". Generator "G" provides a waveform within the specified range of operation wherein the waveform is dynamically changed based on a parameter, wherein the parameter may be related to one of energy delivery, the target tissue and the duration of energy delivery. The parameter may be obtained from a source external to the generator "G", such as, a measured parameter or clinician provided parameter, or the parameter may include an internal parameter obtained, measured or determined by the generator "G".

As seen throughout FIG. **2**, electrosurgical pencil **100** further includes an intensity controller **128** slidingly supported on or in elongated housing **102**. Intensity controller **128** may be configured to function as a slide potentiometer, sliding over and along VDN **127** wherein the distal-most position corresponds to a relative high intensity setting, the proximal-most position corresponds to a low intensity settings with a plurality of intermediate positions therebetween. As can be appreciated, the intensity settings from the proximal end to the distal end may be reversed, e.g., high to low.

The intensity settings are typically preset and selected from a look-up table based on a choice of electrosurgical instruments/attachments, desired surgical effect, surgical specialty and/or surgeon preference, the type of end effector assembly **200** (or end effector assembly **300**) and the arrangement of the active and return electrodes **239**, **234**. The selection of the end effector assembly **200** (or end effector assembly **300**, **500**), the intensity setting, and duty cycle determines the surgical effect. The settings may be selected manually by the user or automatically. For example, the electrosurgical generator "G" may automatically determine the type of end effector assembly **200** (or end effector assembly **300**, **500**) and a predetermined intensity value may be selected and subsequently adjusted by the user or the electrosurgical generator "G".

Turning now to FIG. **3**, a detailed discussion of plug assembly **400** is provided. Plug assembly **400** includes a housing portion **402** and a connecting wire **424** that electrically interconnects the housing portion **402** and the control terminal **215** in the electrosurgical pencil **100** (see FIG. **2**). Housing portion **402** includes a first half-section **402***a* and a second half-section **402***b* operatively engageable with one another, e.g., via a snap-fit engagement. First half-section **402***a* and second half-section **402***b* are configured and adapted to retain a common power pin **404** and a plurality of electrical contacts **406** therebetween.

Common power pin **404** of plug assembly **400** extends distally from housing portion **402** at a location between first half-section **402***a* and second half-section **402***b*. Common power pin **404** may be positioned to be off center, i.e., closer to one side edge of housing portion **402** than the other. Plug assembly **400** further includes at least one a pair of position pins **412** also extending from housing portion **402**. Position pins **412** may be positioned between the first half-section **402***a* and the second half-section **402***b* of housing portion **402** and are oriented in the same direction as common power pin **404**.

A first position pin **412***a* is positioned in close proximity to a center of housing portion **402** and a second position pin **412***b* is positioned to be off center and in close proximity to an opposite side edge of housing portion **402** as compared to common power pin **404**. First position pin **412***a*, second position pin **412***b* and common power pin **404** may be located on housing portion **402** at locations which correspond to pin receiving positions (not shown) of a connector receptacle "R" of electrosurgical generator "G" (see FIG. **1**).

Plug assembly **400** further includes a prong **414** extending from housing portion **402**. In particular, prong **414** includes a body portion **414***a* extending from second half-section **402***b* of housing portion **402** and a cover portion **414***b* extending from first half-section **402***a* of housing portion **402**. In this manner, when the first half-section **402***a* and the second half-section **402***b* are joined to one another, cover portion **414***b* of prong **414** encloses the body portion **414***a*. Prong **414** may be positioned between common power pin **404** and first position pin **412***a*. Prong **414** is configured and adapted to retain electrical contacts **406** therein such that a portion of each electrical contact **406** is exposed along a front or distal edge thereof. While five electrical contacts **406** are shown, any number of electrical contacts **406** can be provided, including and not limited to two, six and eight. Prong **414** may be located on housing portion **402** at a location that corresponds to a prong receiving position (not shown) of connector receptacle "R" of electrosurgical generator "G" (see FIG. **1**A).

Since prong **414** extends from second half-section **402***b* of housing portion **402**, housing portion **402** of plug assembly **400** will not enter connector receptacle "R" of electrosurgical generator "G" unless housing portion **402** is in a proper orientation. In other words, prong **414** functions as a polarization member. This ensures that common power pin **404** is properly received in connector receptacle "R" of electrosurgical generator "G".

Connecting wire **424** includes a power supplying wire **420** electrically connected to common power pin **404**, control wires **416***a*-**416***c* electrically connected to a respective electrical contact **406**, and first RF line **416***d* and second RF line **416***e* electrically connected to a respective electrical contact **406**.

Turning now to FIG. **5**, the end effector assembly **200** of electrosurgical pencil **100** is shown wherein a proximal portion **114** of shaft **112** is configured to mechanically and electrically engage shaft receptacle **104**. Shaft **112** and shaft receptacle **104** are configured to provide a plurality of suitable electrical connections therebetween to facilitate the delivery of electrosurgical energy from the electrosurgical generator "G" (See FIG. **1**) to the active **239** and return electrode **234** of the end effector assembly **200** (or active electrode **339** and return electrode **334** of FIG. **8** or active electrode **539** and return electrode **534** of FIGS. **7**A-**7**D explained in further detail with below).

At least a portion of the shaft **112** is inserted into distal opening **103***b* of the elongated housing **102** to engage shaft receptacle **104**. Shaft receptacle **104** is configured to mechanically and electrically couple the shaft **112** to the elongated housing **102**. Electrical connections may include one or more electrical connectors (or electrical connector pairs) that connect to the active and return electrodes **239** and **234**. Shaft **112** and shaft receptacle **104** may include a locking device, such as, for example, a shaft locking pin that slides into and engages a shaft locking pin receptacle (not explicitly shown). Any suitable securing and/or locking apparatus may be used to releasably secure the shaft **112** to the elongated housing **102**. As described herein, the shaft **112** is interchangeable with the elongated housing **102**. In other embodiments, shaft **112** is integrated into the elongated housing **102** and is not replaceable.

Turning back to FIG. **1**B, a proximal end of the end effector assembly **200** includes a pair of electrical connectors **216***a*, **216***b* that is configured to electromechanically couple to a distal end **116** of shaft **112**. More particularly, electrical connectors **216***a*, **216***b* are configured to mechanically engage respective slots **112***a*, **112***b* defined within a distal end of shaft **112**. In this manner, the end effector assembly **200** may be interchangeable with shaft **112** and shaft receptacle **104** without having to redesign the interchangeable mechanical connection of the shaft **112** with the shaft receptacle **104** of the electrosurgical pencil **100**. Alternatively, shaft receptacle **104** may be designed to selectively accommodate connectors **216***a*, **216***b* to provide the proper electrical polarity to end effector assembly **200** upon engagement thereof.

FIGS. **6**A-**6**B show various views of one embodiment of the end effector assembly **200** for use with the electrosurgical pencil **100**. End effector assembly **200** includes a housing **220** that is configured to mechanically and electrically couple to a distal end **116** of shaft **112**. Housing **220** includes two housing halves **220***a*, **220***b* that cooperate to encase electrodes **234***a*, **234***b* and an active electrode or cutting wire **239**. The housing halves **220***a*, **220***b* may be ultrasonically welded together or mechanically engaged in some other fashion, e.g., snap-fit, adhesive, etc. As mentioned above, the distal end **116** of shaft **112** includes a pair of slots **112***a*, **112***b* that is configured to mechanical engage proximal connectors **216***a*, **216***b*, which, in turn, mechanically and electrically couple to electrodes **234***a*, **234***b* and wire **239**.

The pair of housing halves **220***a*, **220***b* encapsulate the return electrodes **234***a*, **234***b*, an insulative core **240** and the respective distal ends **216***a***1**, **216***b***1** of the connectors **216***a*, **216***b*. Housing halves **220***a*, **220***b* are secured via screw **260** and nut **262**. Nut **262** may be recessed within a nut cavity **227** defined within an outer facing side of housing half **220***b*. Screw **260** may be recessed within housing half **220***a*. More particularly, each return electrode **234***a*, **234***b* affixes to a respective opposing side of the insulative core **240** and is held in place via a pair of rivets **242***a*, **242***b*. Each rivet **242***a*, **242***b* engages a corresponding aperture defined in the insulative core **240** (namely, apertures **243***a*, **243***b*) and each electrode **234***a* (namely, apertures **235***a*, **235***b*), **234***b* (namely, apertures **236***a*, **236***b*). The insulative core **240** may be made from any insulative material, e.g., ceramic, and is dimensioned slightly larger than the dimensions of respective return electrodes **234***a*, **234***b*.

Respective proximal ends **233***a*, **233***b* of each return electrode **234***a*, **234***b* is configured to electrically engage connector **216***b*. Proximal ends **233***a*, **233***b* may include geometry to facilitate connection to the connector **216***b*, e.g., an arcuate flange or other mechanical interface.

Wire **239** is configured to partially seat within a slot **241** defined along the outer peripheral edge of insulative core **240**. Part of the wire **239** remains exposed to allow electrically cutting (as explained in more detail below). Wire **239** is configured to electrically connect to connector **216***a* (e.g., active electrode) which supplies a cutting current when the electrosurgical pencil **100** is activated. Wire **239** may be made from tungsten or any other type of material commonly used in the art.

During assembly and once wire **239** is seated within slot **241**, the wire **239** is tensioned utilizing a tensioning mechanism **270**. Tensioning mechanism **270** includes a pair of bolts **270***a*, **270***b*, a corresponding pair of washers **271***a*, **271***b* and a corresponding pair of nuts **272***a*, **272***b* (See FIG. **6**C). Wire **239** is fed from connector **216***a*, between bolt **270***a* and nut **272***a* pair, and atop washer **271***a* and then around the distal-most edge of the insulative core **240** to be secured between bolt **270***b* and nut **272***b* pair atop washer **271***b*. Each washer **271***a*, **271***b* crimps the wire **239** to the face of the respective nut **272***a*, **272***b*. Various types of washers **271***a*, **271***b* may be used to facilitate this purpose, e.g., spring washers or wave washers. Pinching the wire **239** against the nuts **272***a*, **272***b* via the washers **271***a*, **271***b* provides tension to the wire **239** and secures the wire **239** within the slot **241**. During assembly and testing, the bolts **270***a*, **270***b* may be tightened as necessary to provide a requisite amount of tension to wire **239**. The addition of a washer **271***a*, **271***b* provides consistent and robust tensioning that may be modified as necessary for testing and final assembly.

Each bolt **270***a*, **270***b* engages a corresponding aperture defined in the core **240** (namely, apertures **244***a*, **244***b*) and each electrode **234***a* (namely, apertures **237***a*, **237***b*), **234***b* (namely, apertures **238***a*, **238***b*). Nuts **272***a*, **272***b* may be seated within respective nut cavities **223***a*, **223***b* defined within housing half **220***a*.

Once assembled, end effector assembly **200** may be selectively attached to the distal end **116** of the shaft **112** as explained above. A proximal end of the housing **220** (once assembled) may include a proximal housing support **215** that engages and supports the connectors **216***a* and **216***b*. Proximal housing support **215** may be tapered to facilitate assembly and orientation of the end effector assembly **200** with the shaft **112** or pencil housing **102**.

As mentioned above, the wire **239** may be made from any suitable conductive material such as tungsten, surgical stainless steel, etc. Tungsten is particularly favored since various geometries for the wire **239** may be easily 3D printed providing additional robustness over traditional wire designs while offering an optimized surface area to increase cutting efficiency. Moreover, a sheet including a plurality of tungsten wires **239** may be 3D printed to facilitate the manufacturing process. Moreover, multiple geometries may be easily integrated with the mating geometry of the various mechanical interfaces staying the same. The exposed edge (not explicitly shown) of wire **239** is configured for cutting and is designed to concentrate electrosurgical energy to increase cutting efficiency.

The return electrodes **234***a*, **234***b* are made from a conductive material and insulated from the wire **239** via the insulative core **240**. As mentioned above, the insulative core **240** may be made from a material that provides good thermal and non-conductive properties. Each return electrode **234***a*, **234***b* provides a return path for the electrosurgical energy from the wire **239** such that the circuit is completed.

Turning now to FIGS. **7**A-7D, another embodiment of an end effector assembly is shown and designated end effector assembly **500**. End effector **500** is a double-sided treatment or cutting tool inasmuch as the active electrode **539** is exposed on both sides (or top and bottom) of the end effector assembly **500**. FIG. **8** discussed below discloses a single-sided version of an end effector assembly **300**.

End effector assembly **500** is similar to the end effector assembly **200** described above and, as such, only those details necessary for a complete understanding of end effector assembly **500** are discussed herein. End effector **500** includes a housing **520** including housing halves **520***a*, **520***b* that cooperate to encapsulate the active electrode **539**, return electrode (ground plate) **534** and the tensioning mechanism **570**. One or more bolt and nut arrangements **560***a*, **560***b* may be utilized to secure the two housing halves **520***a*, **520***b* together.

End effector **500** includes a donut-style tip **585** configured to guide active electrode (or wire) **539** therearound for engagement with the tensioning mechanism **570**. Tensioning mechanism **570** is similar to the tensioning mechanism **270** described above. Donut-style tip **585** may be made from ceramic or any other type of durable material that both electrically isolates the active electrode **539** from the return electrode (ground plate) **534** and provides the necessary rigidity to support the active electrode **539** for tissue treatment (e.g., cutting). As shown in FIGS. **7**B-7D, return electrode (ground plate) **534** includes a clevis at a distal end thereof configured to support the donut-style tip **585** thereon. Tip **585** includes a rivet hole **586** disposed therethrough configured to support a rivet **542** therein for mounting the tip **585** to the return electrode (ground plate) **534**. Tip **585** also includes a groove **589** defined therearound configured to securely seat the active electrode **539** therein.

Donut-style tip **585** guides the active electrode **539** therearound to transition the active electrode **539** distally to proximally to permit the active electrode **539** to treat tissue (e.g., cut tissue) on either side of the return electrode (ground plate) **534**. More particularly, and as best shown in FIG. **7**B, active electrode **539** engages active electrical connector **516***a* at a distal end **517***a* thereof and is secured in place via nut **590**. Nut **590** may be hexagonal as explained above or square to allow the nut **590** to securely seat against housing half **520***a* more effectively by reducing the number of sides associated with the nut **590**.

Active electrode **539** is then fed from active electrical connector **516***a* through a hypotube **538***a*, to and around donut-style tip **585** seated within groove **589**, to a second hypotube **538***b* and into engagement with the tensioning mechanism **570**. As explained in detail above, tensioning mechanism **570** provides the necessary tension onto active electrode **539** to ensure effective tissue treatment (e.g., cutting). The donut-style tip **585** provides the necessary rigidity and electrical isolation of the active electrode **539** at the distal end of the end effector assembly **500** to ensure tissue treatment (e.g., cutting).

Return electrode (ground plate) **534** is supported on the housing **520** by bolt and nut arrangements **560***a*, **560***b* as well as connected to the return electrical connection **516***b* by a threaded connection **565** disposed at a proximal end of the return electrode (ground plate) **534**. Distal end **517***b* of the return electrical connector **516***b* is threaded to engage the corresponding threaded connection **565** disposed in the proximal end of the return electrode (ground plate) **534**.

Return electrode (ground plate) **534** and rivet **542** provide a large, robust surface area of electrical return for the active electrode **539** when engaging tissue to facilitate bipolar treatment thereof In addition, the size of the return electrode (ground plate) **534** provides better heat capability to the end effector assembly **500** which reduces the chances of eschar buildup. Further, the donut-style tip **585** is keyed (e.g., riveted) to the robust ground plate **534** to provide stability at the distal end of the end effector assembly **500** and to prevent shifting thereof during use.

Turning now to FIG. **8**, another embodiment of an end effector assembly is shown and designated end effector assembly **300**. This end effector assembly **300** is particularly suited for single-sided tissue treatment or cutting as explained in more detail below.

End effector assembly **300** is similar to the end effector assembly **200** described above and, as such, only those details necessary for a complete understanding of end effector assembly **300** are discussed herein. End effector assembly **300** includes a housing **320** made up of two housing halves **320***a*, **320***b* that are configured to encapsulate both an active electrode **339** and a return electrode (ground plate) **334** similar to end effector assemblies **200** and **500** described above. One or more bolt and nut arrangements **360***a*, **360***b* may be utilized to secure the two housing halves **320***a*, **320***b* together.

End effector **300** includes a donut-style tip **385** configured to guide active electrode (or an active wire) therearound for engagement with a tensioning mechanism (not shown but see FIGS. **7**B-7D). Donut-style tip **385** may be made from ceramic or any other type of durable material that both electrically isolates the active electrode **339** from the ground electrode (ground plate) **334** and provides the necessary robustness and rigidity to support the active electrode **339** for tissue treatment (e.g., cutting). Tip **385** includes a rivet hole (not shown) disposed therethrough configured to support a rivet **342** therein for mounting the tip **385** to the return electrode (ground plate) **334**.

End effector **300** includes many of the same features as described above with respect to end effector assemblies **200** and **500** and, as such, only the differences are described herein. More particularly, active electrode **339** is fed from active electrical connector **316***a* through a hypotube **338***a*, to and around donut style tip **385** seated within a groove (not shown), to a second hypotube **338***b* and into engagement with the tensioning mechanism (not shown). As explained in detail above, the tensioning mechanism provides the necessary tension onto active electrode **339** to insure effective tissue treatment (e.g., cutting). The donut-style tip **385** provides the necessary rigidity and electrical isolation of the active electrode **339** at the distal end of the end effector assembly **300** to ensure tissue treatment (e.g., cutting).

Hypotube **338***a* extends to a point proximate the donut-style tip **385** to insure electrical isolation of the active electrode **339** from the return electrode (ground plate) **334**. An electrically conductive tube **345** is affixed to the return electrode **334** and encapsulates the hypotube **338***a* and active electrode **339**. Tube **345** acts as a return path in conjunction with return electrode (ground plate) **334** and insures one-side tissue treatment.

Return electrode (ground plate) **334** is supported on the housing **320** by bolt and nut arrangements **360***a*, **360***b* as well as connected to the return electrical connector **316***b* in a similar manner as described above with respect to end effector assemblies **200** and **500**.

FIG. **9** shows another embodiment of an end effector assembly, namely, end effector **600**. End effector assembly

600 is similar to the end effector assemblies 200, 300 and 500 described above and, as such, only those details necessary for a complete understanding of end effector assembly 600 are discussed herein. End effector assembly 600 includes a housing 620 that is configured to encapsulate both an active electrode 639 and a return electrode (ground plate) 634. Return electrode (ground plate) 634 includes a series of venting slots 635 defined therein configured to dissipate heat while still maximizing the surface area for electrical return during activation. Any arrangement of venting slots 635 is envisioned to accomplish this purposes, e.g., alternating slots, staggered slots, variously-sized slots, etc.

FIGS. 10A-10C show another embodiment of a tensioning mechanism 770 for use with end effector assembly 700 or any of the above described end effector assemblies or versions thereof. End effector assembly 700 includes a housing 720 made up of two housing halves (not shown) that are configured to encapsulate both an active electrode 739 and a return electrode (ground plate) 734 similar to end effector 200 described above. One or more bolt and nut arrangements 760*a*, 760*b* may be utilized to secure the two housing halves together. A ceramic insulator (or ceramic blade) 780 supports the return electrode (ground plate) 734 on either side thereof along the length of the end effector assembly 700.

In this embodiment, an active electrical lead 716*a* and a return electrical lead 716*b* are concentrically disposed within a single electrical connector 716 that selectively attaches to a pencil 100 similar to the manner described above. Active electrode 739 securely engages active electrical lead 716*a* disposed in the center of connector 716 and return electrode 734 securely engages return electrical lead 716*b* concentrically disposed about the active lead 716*a*. An insulator 717 separates the electrical leads 716*a*, 716*b*.

Active electrode 739 is fed from active electrical lead 716*a* through a hypotube 738*a*, to and around a tip 785 of the ceramic insulator 780 seated within a groove (not shown), to a second hypotube 738*b* and back into engagement with active electrical lead 716*a*. Return electrical lead 716*b* operably engages the return electrode (ground plate) 734 which extends on either side of the ceramic insulator (blade) 780. Return electrode (ground plate) 734 provides a robust surface area for an electrical return path during activation.

Tensioning mechanism 770 includes a C-shaped clip 775 configured to operably engage the housing 720 on either side thereof. C-shaped clip 775 includes a web 776 having upper and lower arms 777*a*, 777*b*, respectively, that extend therefrom. Each arm 777*a*, 777*b* includes a respective finger 778*a*, 778*b* that inwardly extends from a distal end thereof in mutual opposition relative to one another to form the C-shaped clip 775. Arms 777*a*, 777*b* are resiliently biased toward one another. Fingers 778*a*, 778*b* include a friction-based or anti-slip material 779*a*, 779*b* disposed on respective distal ends thereof configured to frictionally grip or secure the active electrode 739.

Housing 720 includes apertures 721*a*, 721*b* disposed on either side thereof that are configured to operably receive the respective inwardly extending fingers 778*a*, 778*b* of clip 775 therein. The resilient bias of arms 777*a*, 777*b* secure and maintain the clip 775 atop the housing 720 once engaged.

Once the active electrode 739 is engaged around the end effector assembly 700 and tip 785 and secured at both ends to the active electrical lead 716*a*, the clip 775 is engaged atop the housing 720. Clip 775 includes an aperture 790 defined therein configured to allow clip 775 to slide atop single electrical connector 716 (FIG. 10B). As can be appreciated, clip 775 is mounted atop single electrical connector 716 during an assembly step.

Upon engagement and as best seen in FIG. 10A, the distal ends of the fingers 778*a*, 778*b* pinch the active electrode 739 on either end thereof to provide additional tension thereon. The friction-based or anti-slip material 779*a*, 779*b* on the distal ends of the respective fingers 778*a*, 778*b* maintain tension on the active electrode 739 on either side thereof. The resilient bias of the arms 777*a*, 777*b* may be customized to provide different amounts of tension depending upon a particular purpose. This may be accomplished by varying the length of one or both fingers 778*a*, 778*b* during molding of C-shaped clip 775, or varying the resiliency of one or both arms 777*a*, 777*b*.

As explained in detail above, the tensioning mechanism 770 provides the necessary tension onto active electrode 739 to ensure effective tissue treatment (e.g., cutting). More particularly, the clip 775, and the tensioning bias associated therewith, tightly controls the amount of tension on the active electrode 739 eliminating concerns associated with shorting (too little tension) and wire fatigue (too much tension).

The various embodiments disclosed herein may also be configured to work with robotic surgical systems and what is commonly referred to as "Telesurgery." Such systems employ various robotic elements to assist the clinician and allow remote operation (or partial remote operation) of surgical instrumentation. Various robotic arms, gears, cams, pulleys, electric and mechanical motors, etc. may be employed for this purpose and may be designed with a robotic surgical system to assist the clinician during the course of an operation or treatment. Such robotic systems may include remotely steerable systems, automatically flexible surgical systems, remotely flexible surgical systems, remotely articulating surgical systems, wireless surgical systems, modular or selectively configurable remotely operated surgical systems, etc.

The robotic surgical systems may be employed with one or more consoles that are next to the operating theater or located in a remote location. In this instance, one team of clinicians may prep the patient for surgery and configure the robotic surgical system with one or more of the instruments disclosed herein while another clinician (or group of clinicians) remotely controls the instruments via the robotic surgical system. As can be appreciated, a highly skilled clinician may perform multiple operations in multiple locations without leaving his/her remote console which can be both economically advantageous and a benefit to the patient or a series of patients.

For a detailed description of exemplary medical work stations and/or components thereof, reference may be made to U.S. Patent Application Publication No. 2012/0116416, and PCT Application Publication No. WO2016/025132, the entire contents of each of which are incorporated by reference herein.

Persons skilled in the art will understand that the structures and methods specifically described herein and shown in the accompanying figures are non-limiting exemplary embodiments, and that the description, disclosure, and figures should be construed merely as exemplary of particular embodiments. It is to be understood, therefore, that the present disclosure is not limited to the precise embodiments described, and that various other changes and modifications may be affected by one skilled in the art without departing from the scope or spirit of the disclosure. Additionally, the elements and features shown or described in connection with certain embodiments may be combined with the elements and features of certain other embodiments without departing from the scope of the present disclosure, and that such modifications and variations are also included within the scope of the present disclosure. Accordingly, the subject matter of the present disclosure is not limited by what has been particularly shown and described.

While several embodiments of the disclosure have been shown in the drawings, it is not intended that the disclosure be limited thereto, as it is intended that the disclosure be as broad in scope as the art will allow and that the specification be read likewise. Therefore, the above description should not be construed as limiting, but merely as exemplifications of particular embodiments. Those skilled in the art will envision other modifications within the scope and spirit of the claims appended hereto.

The invention claimed is:

1. An electrode assembly for an electrosurgical instrument, comprising:

a housing including an active electrical connector and a return electrical connector configured to operably engage a distal end of an electrosurgical instrument shaft, the housing encapsulating an elongated return electrode and a pair of insulative tubes configured to house an active electrode, the elongated return electrode having a distal end including a clevis and a proximal end operably engaged to the return electrical connector, the active electrode being operably engaged at one end to the active electrical connector;

an insulator operably engaged to the clevis of the elongated return electrode, the insulator configured to support the active electrode; and

a tensioning mechanism configured to operably engage an opposite end of the active electrode and tension the active electrode about the insulator during assembly.

2. The electrode assembly of claim **1**, wherein the tensioning mechanism includes at least one bolt, at least one nut and at least one washer, the at least one washer configured to crimp the active electrode against the at least one respective nut to vary the tensioning of the active electrode during assembly.

3. The electrode assembly of claim **2**, wherein the at least one washer is at least one of a spring washer or a wave washer.

4. The electrode assembly of claim **1**, wherein the proximal end of the return electrode is threadably engaged to the return electrical connector.

5. The electrode assembly of claim **1**, wherein the insulator is secured to the clevis of the elongated return electrode by a rivet.

6. The electrode assembly of claim **1**, wherein the insulator includes a groove configured to seat the active electrode.

7. The electrode assembly of claim **1**, wherein the active electrical connector operably secures to the housing via a square-shaped nut.

8. An electrode assembly for an electrosurgical instrument, comprising:

a housing;

an active electrical connector extending from a proximal end of the housing;

a return electrical connector extending from the proximal end of the housing and configured to couple to an electrosurgical instrument;

a return electrode having a distal end portion extending distally from the housing and a proximal end portion disposed within the housing and coupled to the return electrical connector;

an active electrode having a first end and a second end opposite the first end, the first end of the active electrode coupled to the active electrical connector;

an insulator coupled to the distal end portion of the return electrode, the insulator configured to support the active electrode; and

a tensioning mechanism disposed within the housing and coupled to the second end of the active electrode, the tensioning mechanism configured to tension the active electrode.

9. The electrode assembly of claim **8**, wherein the tensioning mechanism includes a nut and a washer, the washer configured to crimp the active electrode against the nut to vary the tensioning of the active electrode.

10. The electrode assembly of claim **8**, wherein the proximal end portion of the return electrode is threadably coupled to the return electrical connector.

11. The electrode assembly of claim **8**, wherein the distal end portion of the return electrode includes a clevis coupled to the insulator.

12. The electrode assembly of claim **11**, wherein the insulator is coupled to the clevis of the return electrode by a rivet.

13. The electrode assembly of claim **8**, wherein the insulator includes a groove configured to seat the active electrode.

14. The electrode assembly of claim **8**, wherein the active electrical connector is secured to the housing via a square-shaped nut.

15. An electrode assembly for an electrosurgical instrument, comprising:

a housing;

an active electrical connector extending from a proximal end of the housing;

a return electrical connector extending from the proximal end of the housing;

a return electrode having a distal end portion extending distally from the housing and a proximal end portion disposed within the housing and coupled to the return electrical connector;

an active electrode coupled to the active electrical connector;

an insulator disposed at the distal end portion of the return electrode, the insulator configured to support the active electrode; and

a tensioning mechanism disposed within the housing and configured to tension the active electrode.

16. The electrode assembly of claim **15**, wherein the active electrode has a first end coupled to the active electrical connector and a second end, opposite the first end, coupled to the tensioning mechanism.

17. The electrode assembly of claim **15**, wherein the tensioning mechanism includes a nut and a washer, the washer configured to crimp the active electrode against the nut to vary the tensioning of the active electrode.

18. The electrode assembly of claim **15**, wherein the proximal end portion of the return electrode is threadably coupled to the return electrical connector.

19. The electrode assembly of claim **15**, wherein the distal end portion of the return electrode includes a clevis coupled to the insulator.

20. The electrode assembly of claim **19**, wherein the insulator is coupled to the clevis of the return electrode by a rivet.

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